SYSTEMS OF ELECTRIC IGNITION FOR MOTOR-CARS.

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CONTENTS.

PREFACE TO THE SECOND EDITION.

THE first issue of this book having run out of print with gratifying rapidity, I have been called upon to revise the matter for a second edition. This has proved no easy task, as changes and developments in electrical ignition have been very marked during the last three or four years; and though the High Tension Magneto is still the most popular system it is by no means certain that it will be the ultimate type. A perusal of the following pages will show that there is a greater variety of electrical ignition apparatus on the market now than at any earlier date.

In nearly all cases many patterns of magnetos are made by each manufacturer and they generally include a dual system; so the specimens described are taken by way of example only.

I have again to thank those firms who have assisted me by providing facilities for describing their manufactures and lending me blocks for illustration purposes.

D. L.

2, Harcourt Buildings,
Temple.
1 June, 1911.

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CHAPTER I.

The Elements of Electricity.

THERE is no part of the anatomy of the automobile with which the average motorist is less acquainted than the ignition. This being the case, it will be necessary to a proper education in the subject that we should run over some of the preliminary ground in order to provide a firm basis from which to take our further flights.

The nature of electricity is so elusive that it is not to be wondered at if the student suspects that neither his teacher nor anyone else really knows what he is talking about, and that learned looks and cryptic phrases are nothing more than cloaks of ignorance. He feels that he must sift the wheat from the chaff to the best of his ability; and that, as a general rule, he must be content to assume (to the verge of self-imposition) in order to provide any sort of foundation for the store of knowlege he may aim at building up.

In this book we shall endeavour to deal with the subject from the uninitiated's point of view, and as sympathetically as may be. As an earnest

of our good faith we cannot do better than admit, at once, that no theory as to what electricity *is* has, so far, received general acceptation. We, poor humans, do not know of what it consists, if indeed it really consists of anything; but on the other hand we have a knowledge, that is exceedingly useful (though it may be wofully incomplete), of what it can *do*. In many of its ways it

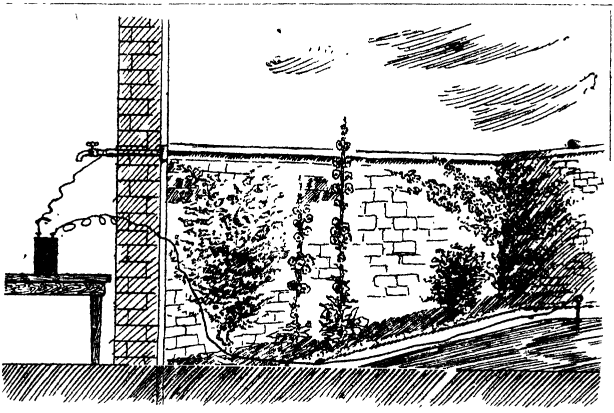
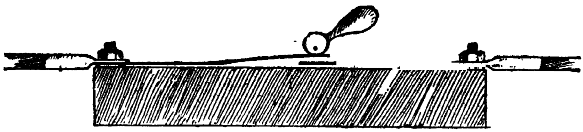


Fig. I.—The Earth as a Conductor.

resembles a liquid, though more inclined to travel along the exterior of a solid body than through the interior of a hollow one, and absolutely regardless of the rule that water always tries to find its own level. It also displays a great readiness to be conducted by some metals, and an equal reluctance to passing or traversing some vegetable and other substances. These traits give

us opportunities for leading or conducting and for confining or insulating our mysterious friend ; but it is mighty particular as to the perfection of the insulator, and is always ready to take advantage of any defect therein, provided the defect gives access to a conductor.

Another peculiar characteristic of electricity is that, given a supply of it, you cannot disperse it unless there is some return conductor ; or, in other



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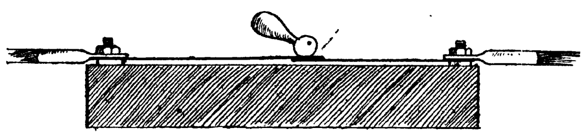

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Fig. 2.—A Simple Switch.

words, there must be a complete circuit. But to be quite candid the current will adopt means for returning that can hardly be considered "playing the game." Suppose we have two conducting wires joined to our store of electricity and the free end of one of these is connected to, say, the household water pipe, while the free end of the other is buried at the end of the garden (Fig. 1) ; we might well be excused for supposing that all is safe and nothing will happen. Not a

bit of it! The earth forms a capital conductor, we have a complete circuit, and our store will soon be exhausted. The strange part of it is that if you had a score of such affairs and connected some conductors to the pipe and planted some in the garden and left others hanging clear, the different sets would sort themselves out, and you would not find the current starting from one source coming back to another, nor even the different complete sets getting mixed up with each other.

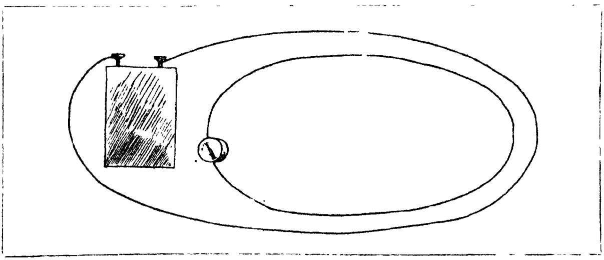

Fig. 3.—Induced Current.

But instead of wasting our electricity by running it through a continuous complete circuit, we can connect the conductors to some apparatus where the current will achieve some useful object; and further we can provide a kind of tap in one of the conductors by which we can turn the current on and off as desired. This tap is called a "switch" (Fig. 2) or a "contact-breaker" according to circumstances, and by working it mechanically we can cause the current to perform at stated intervals. Under these circumstances,

too, the circuit can be completed either by a continuous return wire or by "earthing" it.

Now, while the return currents have an unerring instinct by which they find their ways home through the dark places of the earth, without disturbing each other; yet, if a second conductor be arranged near the first (Fig. 3), the

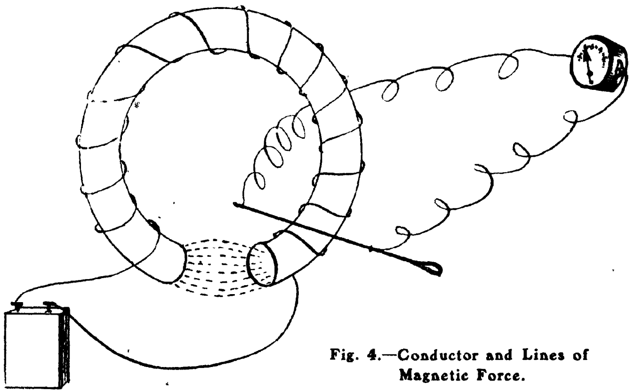

Fig. 4.—Conductor and Lines of Magnetic Force.

passage of a current through the first will be accompanied by the passage of an "induced" current through the second.

A similar result ensues if a conductor (Fig. 4) be passed between the ends of a horseshoe magnet. When the conductor is passed inwards a current is set up in one direction, and when it is passed outwards the current is reversed. The electric current in the conductor is due to the cutting of certain "lines of force" passing across from one end to the other end of the magnet.

The existence of these lines of force can be easily shown. Lay an ordinary horseshoe magnet on a table. Take a single sheet of thin white paper and lay it on the magnet, and on the paper sprinkle a few fine iron filings in the neighbourhood of the ends of the magnet. Now tap the paper lightly and the lines of force will be exhibited by the filings arranging themselves in certain fairly well defined curves extending from the one end to the other. It is the cutting of these curves by the conductor that induces the electric current in the latter. This may be regarded as a conversion of magnetism into electricity. We can also produce a similar change of electricity into magnetism. Take a bar of iron (a neat bundle of soft iron wires of equal length is best) and around it twine a length of electrical wire, the ends of which are connected to the terminals of an electric generator. Introduce a switch into the length of wire (Fig. 6). Switch on the current and it will be found that the iron has become magnetic; switch off, and lo, the magnetism has departed! This kind of magnet is called an electro-magnet, the magnetism being due to the electric current passing through the

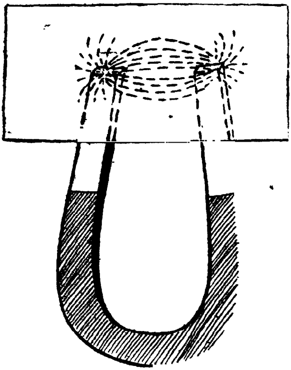

Fig. 5.—Iron Filings showing Lines of Force.

wire and lasting only while the current is passing. The horseshoe magnet in Fig. 5, on the other hand, is a "permanent" magnet; once charged it retains its magnetism for some years.

The ends of a magnet are known as its poles; one is the north and the other the south. Why "north" and "south"? Because if one balances a permanent bar magnet on a point, one end will point towards the north and the other to the south. If a fine needle be rubbed on a permanent magnet, after having been thoroughly dried, and then be laid carefully on some water in a bowl it will float, and will take up a north and south position. That is the principle governing the mariner's compass. The mere floating is, of

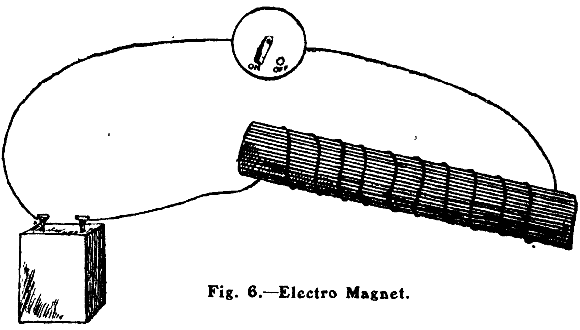

Fig. 6.—Electro Magnet.

course, due not to the magnetism but to the surface tension of the water. If the current be sent first in one direction and then in the other through the wire winding of an electro-magnet, the respective poles will change from north to

south alternately; but in a permanent magnet no such change takes place. The north pole of one magnet will attract the south or negative pole of another magnet, but like poles repel each other. Hence, in the compass it is not, properly speaking, the north pole of the needle, but the "north seeking" or south pole, that points to the north.

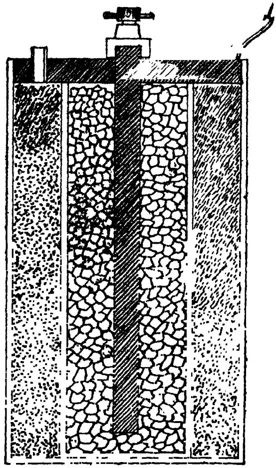

Fig. 7.—Section of Dry Battery.

Batteries.

Formerly the most common way of obtaining a supply of electricity, for our purpose, was, not by cutting magnetic lines of force, but by chemical action; and although this method is now seldom used except for starting purposes and lighting, the battery system must be described before the magneto. The matter of polarity arises here again in a somewhat different way. The electrician divides substances according to their "polarity," and the polarity may be relative; that is to say, a substance may be positive to one thing and negative to another. Thus, silver, while positive to most metals is negative to gold. Now, if a positive substance and a negative substance

be placed in a vessel containing an acidulated liquid, and the two substances be connected by a conductor, a current of electricity will flow through the conductor. Take a bronze penny and a piece of zinc of about the same size, clean them well, and place one on your tongue and the other under it, letting their edges touch in front. Then, if your saliva is sufficiently acid, you will feel a slight current of electricity passing through your tongue. Here the copper is the positive element and the zinc is the negative, and these two metals were commonly used for obtaining electricity until comparatively recently, when it was found that the copper might with advantage be replaced by carbon. The liquid used in cells for working electric bells (for which this kind of cell is generally employed) consists of a solution of sal ammoniac. But the liquid is not necessarily free, and, for motor ignition purposes, the solution is replaced by a nearly dry mixture of sal ammoniac and plaster of Paris. This gets over the splashing trouble right away.

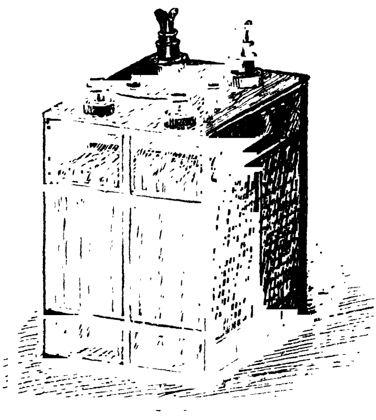

Fig. 8.—Accumulator.

It must not be thought that the electricity

may be thus obtained free, gratis, and for nothing. There is no back way to perpetual motion along here. The negative element — the zinc — disappears gradually in the chemical process, and there is waste in other ways. Moreover, it is practically impossible to restore a dry cell, so it is comparatively expensive to use.

A collection of cells is called a battery, whether they be of the primary kind we have just referred to or of the sort we are now about to describe. These latter are called "secondary" cells because they must be charged with electricity before any current can be got out of them, while no preliminary charging is required in primary cells. Secondary cells are often called storage batteries or accumulators. But these terms are not strictly correct, the supply of current from a secondary battery being, not the electricity put into it, but the result of the chemical changes set up by the charging in the first place, and the completion of the battery circuit in the second. In a secondary battery the positive and negative plates are both made of lead in grid form. The negative plates number one more than the positive in each cell. The spaces in the grids are filled with oxide of lead paste. The plates are steeped in a liquid "electrolyte," consisting of dilute sulphuric acid. Sometimes the electrolyte takes the form of a jelly, but the freedom from splashing is obtained at the expense of some efficiency in the cell. When an electric current is passed one way through the cell, the paste in the negative plate is changed into pure lead, and that in the positive plate

becomes peroxide of lead. The battery is now ready to give off electricity in the other direction, and, as it does so, the pastes gradually return towards their original conditions.

In dry batteries the cells themselves are often made of the zinc elements, but in secondary batteries the plates are usually suspended in transparent celluloid cases, so that the interior can be readily inspected.

Electric currents are not all of the same value. Perhaps you can recollect an evening party in childhood's days, when an amiable gentleman invited you to take hold of a pair of brass handles. He then proceeded to twiddle a third handle connected with a box containing an undecipherable collection of reels of green silk and "uvver fings." After a little you felt a sensation of pins and needles, and the sensation grew and grew until your arms seemed to consist wholly and exclusively of pins and needles, and though you were quite willing to restore the brass handles to the kind gentleman, you simply could not until he very considerately mitigated his twiddling antics. Well, that was an electric current that got stronger and subsequently weaker ; and if the interesting experiment did not encourage you to pursue the study of electricity with avidity, it is not much to be wondered at.

The current can be measured in two respects, viz., as to quantity (in amperes or amps), and as to pressure or intensity or tension (in volts). And amps multiplied by volts are called watts. Doubtless you will at once see the appropriateness of

these terms; *volts* are so called because they do not stand for *vol*ume, and so on!

Now we must make another confession. It is not strictly true that there must be a complete circuit before the current will "work." If the circuit includes two parts that can be brought into contact and separated at will, you may notice that when you separate them there is a small spark. That spark is an indication of the fact that the current continues to flow for a moment after the circuit is broken. That is only a slight infraction of the rule; but there is a greater. Supposing the two parts never had been in contact and are standing at a short distance apart after you "turn on the tap." Well, if the current is of high pressure or tension and the parts are not too

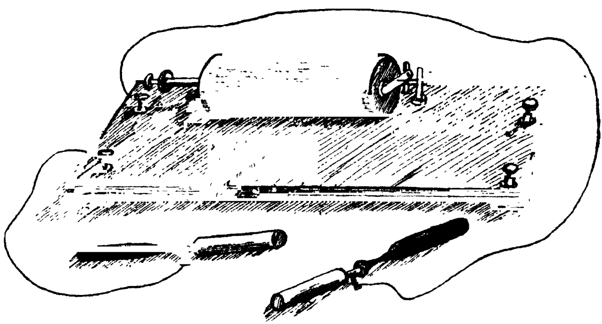

Fig. 9.—Shocking Coil.

far apart, it will jump across the gap in the shape of a thread of flame. While all materials may be considered as conductors, some are so inefficient as to be classed as non-conductors or insulators.

Air is one of these, and when the high tension current reaches across the gap, it is because it is strong enough to force its way through the air rather than because the air conducts it. If the air is compressed the current has greater difficulty

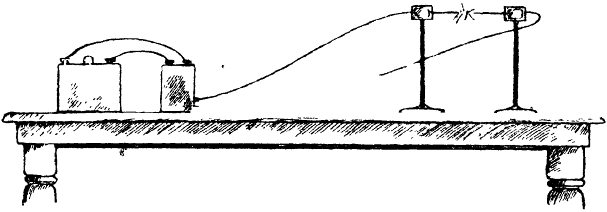

Fig. 10.—Battery, Coil, and High Tension Spark.

in jumping the gap, while if it be rarefied the current can complete the circuit more easily.

In the next chapter is described the means by which some of these principles are carried into practice in one system of electric ignition.

CHAPTER II.

The Battery and Coil System.

THE ordinary system of battery ignition comprises a battery for providing a low tension current, a contact breaker for bringing that current into operation when required, a coil for transforming the low tension current into a

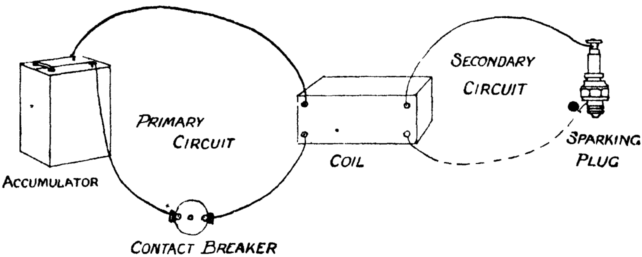

Fig. II.—Battery and Coil System.

high tension current, and a plug by which the high tension current is caused to exhibit itself as a spark or flame in the combustion chamber. In addition there are, of course, the wires for making the necessary connections, and means for causing the contact breaker to operate earlier or later in the cycle of operations. Often there are one or more switches for changing over from one accumulator to another and for breaking the circuit, spark intensifiers, and sometimes in the case of an engine having two or more cylinders, a distributer for feeding the high tension current to each plug as required.

Contact Breakers.

To deal with these several constituents more in detail, we will commence with the contact breaker. Of these there are two or three kinds in use at the present day. The simplest of these is the kind known as the "make and break" contact breaker (Fig. 12). On a shaft, driven positively by the motor at half the speed of the crank-shaft, is fixed a cam. A plate is centred on the half-speed shaft and is movable through a certain angle round the same. On this plate are mounted two pillars. To one pillar is secured a spring blade carrying a block or roller at the free end. At an intermediate point the blade

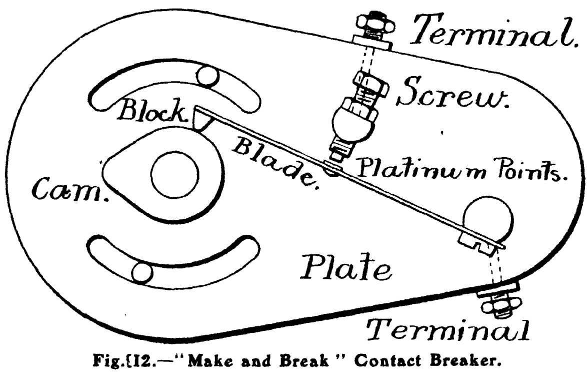

Fig. 12.—"Make and Break" Contact Breaker.

carries a small block of platinum on the back, and opposite this platinum contact is mounted a screw having a platinum tip. This screw is threaded through the other pillar. The pillars are in electrical connection with terminals on the plate, and

these terminals are connected to the coil and the battery. The connection to the coil is always by a wire; the connection to the battery is occasionally by wire, but generally mainly by earth. When the half-speed shaft turns the cam round so that the projection lifts the end of the blade, the platinum on the blade is brought into contact with the tip of the screw, and the current passes through the platinum points, the blade and the screw, from the coil to the battery. Hence as the battery has one wire running directly to the coil, the primary or low tension circuit is completed. The current therefore flows through the circuit, and as the coil is included in this circuit a high tension current is induced.

It will be obvious that by rocking the plate on its axis, the cam may be caused to operate on the blade earlier or later in the rotation of the half-speed shaft, and hence earlier or later in the cycle of operations of the motor. The range of adjustment of the plate, and hence of the timing, allows of the sparking at the plug (which is practically simultaneous with the making and breaking of contact at the contact breaker) being made to occur either some time before the piston has completed its compression stroke, or not until it has descended some distance on the driving stroke, or at any intermediate position. Under the former conditions the spark is advanced; under the latter it is retarded. The movement of the plate has, in a few cases, been made to take place automatically according to the speed of the engine; but the almost universal practice is to

utilise the making and breaking of the contact, and hence the timing of the spark, as a means of controlling the speed of the engine by instituting positive connections between the plate and a lever ready to the driver's hand, usually on the top of the steering wheel.

In another system (Fig. 13), instead of fixing a cam to the half-speed shaft, a ring or collar of vulcanised fibre or other insulating material is secured thereto. A block of brass is let into the collar and is connected radially from the shaft to the surface of the collar. The plate and blade are used as before, but the platinum contacts and the screw are absent. The end of the blade rubs on the collar all the time. The blade is again connected to the coil by a wire; but instead of a wire running back to the battery, the brass insertion and the half-speed shaft form a conductor for the current, and lead it back through other metallic parts of the car to a short wire coupling up such metallic parts to the negative terminal of the battery. An advantage of this type of contact breaker is that it requires little, if any, adjustment; on the other hand,

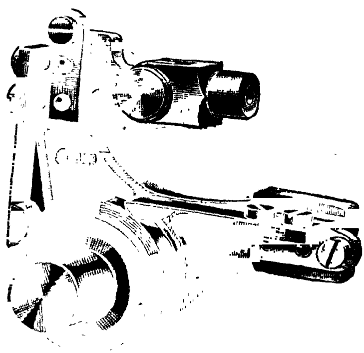

Fig. 13.—External Wipe Contact Breaker for Two-cylinder Motor.

the "earth" return cannot be considered as satisfactory as the return by direct wire, as the "earth" is more or less adulterated by the oil in the half-speed shaft bearings and other imperfect connections. Each time the brass block comes round and makes contact with the blade, the primary or low tension circuit is completed, and a high tension current is induced in the coil.

A third system is similar to the second in that it has a wiping action, but in this case it is the equivalent of the blade that is carried round while the metallic block keeps still. An arm is fixed to the half-speed shaft, and pivoted in the end of it is a lever. One end of the lever carries a roller and is forced outwards by a spring connected to the other end. The roller runs round a track formed by the inner surface of a ring of insulating material. Into this ring is introduced a metal block in connection with a suitable terminal. When the roller makes contact with the block the circuit is completed—passing through the block, the roller, the lever, and the arm to the half-speed shaft, and thence by earth back to the battery. Means for timing is provided by turning the plate which carries the ring.

In the above descriptions it has been assumed that the contact breakers are for single-cylinder engines, but it will be obvious that by increasing the number of pillars and blades in the first and second devices, or by increasing the number of blocks in the third device, the number of makes and breaks per revolution of the half-speed shaft can be increased to suit any larger number of

cylinders. Of course the various parts must be arranged in the proper relative positions.

Take the case of a two-cylinder engine and a contact breaker of the third kind, known as the "internal wipe." If the cylinders are arranged to fire at equal intervals, the two cranks being in line, or at 360 degrees as it is sometimes expressed, in such a case the two blocks in the roller track must be at 180 degrees. But if the cranks are diametrically opposite or at 180 degrees, then the blocks must be at 90 degrees.

The current begins to flow as soon as the parts make contact, but with a plain coil it is at the moment of breaking that the real effect is felt. It is important that the breaking should be as sudden and complete as possible. In a wipe contact breaker, therefore, especially if used with a plain coil, one must be careful to see that there is no conductor by which the current can continue to flow after the blade or roller has left the block. There is a tendency for small particles of metal to be rubbed off the block and distributed along the surface of the insulating material, and

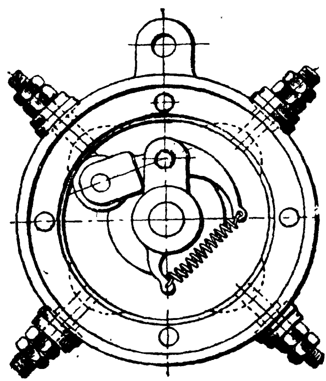

Fig. 14.—Internal Wipe Contact Breaker for Four-cylinder Motor.

in course of time these particles form a conductor through which a certain amount of current will pass. The defect may of course be cured by careful cleaning, but prevention is better than cure, and this is effected by lubrication. The presence of oil in a contact breaker is not perhaps ideal, but it is better to have oil than an attenuated break.

Induction Coils.

As we have already seen, when an electric current is passed through a wire circuit, another current will be discernible in a circuit adjacent thereto. Now the intensity of the two currents will vary according to the length and thickness of the wires constituting the two circuits. Thus, if a current of large volume and low pressure be passed through a comparatively short thick wire, the current induced in a long thin wire will be of small volume and high pressure, and *vice versâ*. In motor-car ignition we have the large volume and low pressure current provided by the battery, at intervals regulated by the contact breaker; and the high pressure current necessary for producing the requisite spark at the plug is obtained from the battery current by the Induction Coil.

The coil as a whole is built up as follows:—In the centre is arranged a bundle of fine soft iron wires, this being employed to promote the induction effect. Around this "core" is wound a comparatively short thick primary wire, the ends of which are coupled up to terminals on the coil case and thence directly and indirectly to the respective terminals of the battery either wholly by wires or,

as to part of the return, by earth. Over the primary wire is passed a substantial insulator, as, for example, a vulcanite tube. Around the insulator is wound several layers of very fine wire, and between each layer is introduced a sheet of insulating material. One end of the high tension wire is connected to a terminal which also carries the wire leading to the sparking plug, and the

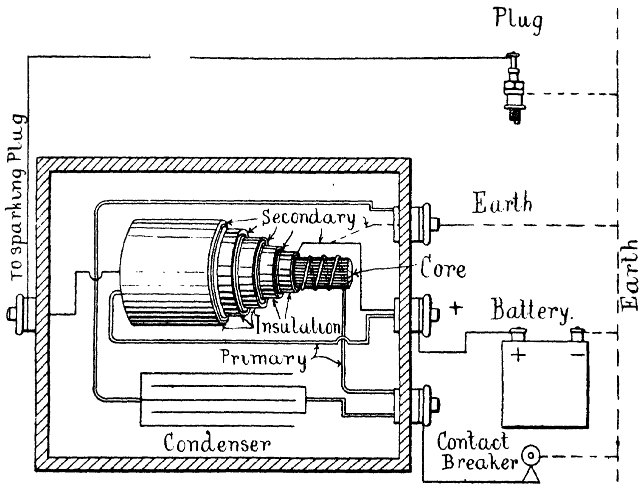

Fig. 15.—Sectional View of the Coil.

other end of the high tension wire is connected either to the earth terminal or to one end of the primary wire. The whole of the coil windings or wiring is encased in insulating material, generally paraffin wax, forming a solid packing by which the coil is mounted in its case.

In addition to the coil proper is a device known as a condenser. This consists of a number of sheets of tin foil connected alternately to two separate wires. Between the sheets of tin foil are introduced insulating sheets of paraffin paper, mica, or the like, and the wires are connected to the inner ends of the contact breaker and earth terminals respectively.

This form of coil is generally employed with the make and break contact breaker, the first above described. When the cam lifts the blade so as to bring the platinum point thereon into contact with the corresponding point on the screw, the circuit from the battery to the coil and back from the coil to the battery through the contact breaker is completed, as we have seen, and the current flows throughout the entire circuit. As the current passes through the primary winding of the coil it induces a current in the secondary or high tension winding of the coil. And here the analogy to water comes in again. If you turn on the tap in a water pipe, the whole pipe is not instantaneously filled with water ; it takes a little time before the pipe is fully charged. Further, if the flow of water is suddenly stopped by turning off the tap there is more or less of a shock. A similar thing happens in the ignition system, only far more rapidly ; the electricity charges the wires gradually and then, when the contact is broken, there is something like a shock and the high tension current jumps across the points of the plug in the form of a spark.

There is at the same time a small spark at the

points of the contact breaker, as the low tension current continues to flow momentarily as the points separate. Platinum is used for these points because of its highly refractory nature, and even this metal does not stand indefinitely, while points of inferior metal are very unsatisfactory. The sparking at the contact points would be a good deal worse were it not for the condenser. When the circuit is broken by the separation of the contacts the current is passed into the condenser, which acts as a kind of dashpot, the current flowing backwards and forwards like a pendulum coming to rest. Not only does the condenser act as a kind of relief valve in this way, but it also expedites the charging of the wires the next time the circuit is completed by giving out again the electricity stored in it. Are we quite certain that is really how the condenser operates? No, we are not; but the explanation we have given seems about the most feasible of those generally put forward. It corresponds with practice, any way.

The trembler coil is generally used in conjunction with one of the wipe contact breakers already referred to. It will be obvious from a comparison of the illustrations that a wipe contact breaker allows the low tension current to flow for a longer time than when a make and break contact breaker is employed. In addition to the contact breaker on the motor there is a contact breaker mounted upon the coil itself. It consists of a light spring blade carrying a block or "armature" opposite the end of the soft iron wire core. On the blade is a platinum point, and there is a

similar point on a screw mounted in the metal bridge passing over the blade; the blade itself is secured to a pillar which also forms an internal terminal. It will be seen that the contact breaker on the coil, as well as the contact breaker on the

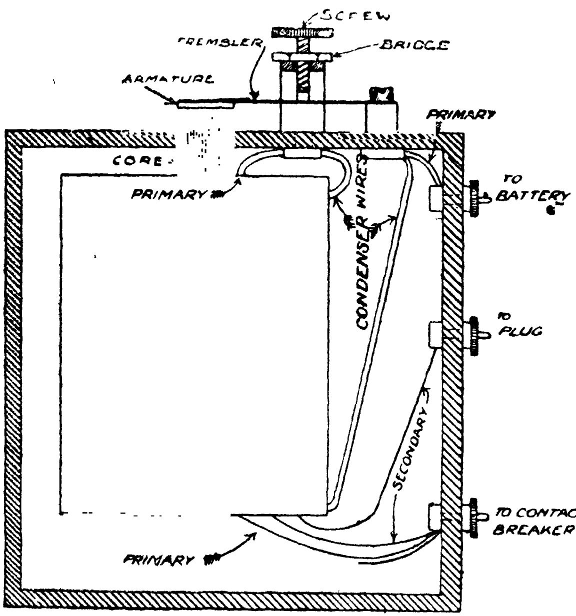

Fig. 16.—Trembler Coil.

engine, is introduced into the primary circuit. The platinum points of the coil contact breaker are normally in contact, so that when the circuit is completed at the engine contact breaker, the

current passes through the primary circuit including the coil contact breaker. The effect of the low tension current is not only to produce a high tension current in the secondary winding, but it also excites the core, causing it to operate as an electro magnet. The core therefore immediately attracts the armature, but in doing so it bends down the trembler blade and separates the platinum points. This breaking of the contacts means breaking of the primary circuit, and hence the cessation of the excitation of the core, which immediately releases the armature and allows the blade to spring upwards and complete the circuit once more. Then the current flows again, excites the magnet, and breaks the coil contacts; and so on, this series of events happening a large number of times while the contact breaker on the engine is passing through the "make" position.

Every operation of the coil contact breaker corresponds to the induction of a current in the secondary winding of the coil and a spark at the plug, so that in this case the sparking takes place in the engine practically on the making of contact by the engine contact breaker, instead of at the breaking thereof as in the plain coil device.

In the illustration of the trembler coil it will be observed that the condenser is connected across the coil contact breaker, one of the condenser wires being connected to the trembler screw through the bridge which carries it, and the other to the pillar on which the trembler blade is mounted. As a condenser operates with extreme rapidity it is particularly useful in connection with

a coil contact breaker which itself operates at many scores of times a second.

The trembler coil therefore provides a series of high tension currents in very rapid succession.

Plugs.

The sparking plug itself consists primarily of two points set at a suitable distance apart, about 1-32 in. for coil ignition and 1-50 in. for magneto. One point is connected to the coil or magneto directly by a wire, and the other indirectly through the metalwork of the machine. To ensure that the current shall pass across the gap between the points, it is necessary that the two conductors shall be insulated from one another.

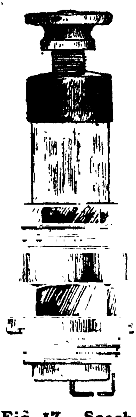

Fig. 17.—Sparking Plug.

The conditions are met by employing a screw-threaded metal socket which is fitted in the combustion head with a gas-tight joint and carries the earthed point. The other point is mounted on one end of a thin rod which is surrounded by a porcelain or mica insulator and is secured in the socket by a gland. The outer end of the insulated rod is fitted with a suitable terminal for the attachment of the wire from the coil. The plugs vary somewhat in construction according to the form of the insulation, and also as to the nature of the points. Frequently the latter are simply the free ends of wires, but there are variations, such as an irregularly shaped body

being employed instead of the inner point, and this is adapted to provide a number of points from which sparks may flow to the body of the plug.

Owing to the virile nature of the current produced by a magneto it is necessary to employ more refractory electrodes for magneto sparking plugs, than for those employed with battery and coil ignition.

In connection with the sparking plug, a device is sometimes employed called a spark gap or intensifier. This, in a way, is a repetition of the plug itself, comprising, as it does, a short break in the high tension circuit, the object being to increase the shock by duplicating the jump. Being arranged outside the cylinder, it is useful in that it permits one to see whether the ignition system is working properly, especially in case of a multi-cylinder engine, as a spark is visible between the points of the intensifier when all is acting as it should be. It is best to enclose the points of the intensifier in a glass tube, as otherwise the spark is liable to ignite any petrol vapour that may accumulate close to the same. Sometimes, owing to defective combustion or lubrication, carbon will be deposited on the inner end of the sparking plug and will form a conductor by which the electricity will prefer to travel on *terra firma*, so to speak, instead of jumping the gap ; but with a spark intensifier the current will usually take the leap under these unfavourable circumstances. Some may think that an intensifier's cloaking of evils in this manner is not altogether ideal, and the contention is certainly sound as far as it goes.

The Lodge Double-Pole Plug.

In the Lodge double-pole plug both electrodes are insulated and provided with terminals. The object is to employ two or more plugs in each cylinder and fire the charge simultaneously at a corresponding plurality of points, so that the combustion may be effected more rapidly and the

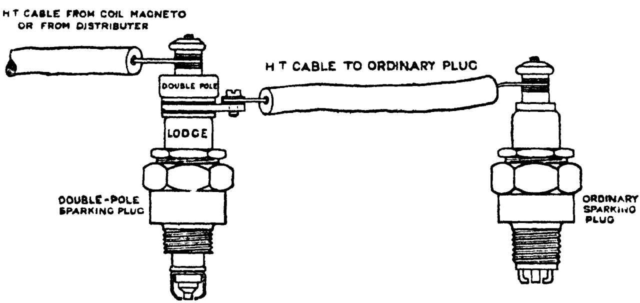

Fig. 18.—Diagram of Connections for Lodge Double-Pole Plug.

impulse made more powerful. Generally one double-pole plug and one ordinary single-pole plug are used. The high tension current is led first to one terminal of the double-pole plug from the magneto, coil or distributer, as the case may be. The spark jumps across the points of this plug; but instead of the current passing direct to earth, it is led up to the other terminal of the plug, and thence by a short lead to the terminal of the second

plug. There the current produces a second spark and goes to earth in the ordinary way. The first plug acts as a "spark gap" to the second one, but the gap being enclosed in the combustion chamber assists in firing the charge. The sparks occur simultaneously.

Wiring.

The wiring between the battery and the coil and between the coil and the plug calls for a few remarks. The wire for the primary circuit should be of good sectional area but need not be very heavily insulated, as the conditions are similar to those of a large volume of water flowing slowly through a pipe. The wire from the coil to the plug, however, requires heavy insulation, as the conditions here are like those of a small quantity of water being forced through a pipe at very high pressure. In each case finely stranded wire should be employed to provide the necessary flexibility to withstand vibration, and allow of bending about as required. While the wires from the battery to the coil and from the coil to the plug should be carefully insulated and kept, especially as to the latter, as much as possible away from the neighbourhood of metalwork, the wire from the contact breaker to the battery requires practically no insulation, as the current is anxious to get back to its source and is not particular, nor does it much matter, what path it takes.

It is always a good plan to carry two accumulators, so that if one gives out the other may be

brought into use. In order that the operation may be performed quickly the two accumulators should be already wired up in conjunction with a switch, so that by moving the handle of the switch either accumulator may be put to work as required. The two accumulators are wired up to the rest of the primary circuit "in parallel," that is to say, two wires lead from the positive terminals on the respective batteries to the single "battery" terminal on the coil, and two other wires lead from the negative terminals on the battery to one of the terminals on the contact breaker.

Batteries can be arranged either "in parallel" or "in series." Parallel wiring we have described above. The two cells of each battery are arranged in series; that is to say, the positive terminal of one cell is connected by a wire or by a bridge-piece to the negative terminal of the other cell. If one should be stranded with two exhausted batteries, one may sometimes get home by coupling them up in series. The positive terminal of one battery would be connected to the coil; the negative terminal of the other battery would be earthed to the contact breaker, and the negative terminal of the first battery would be wired direct to the positive terminal of the second battery. But this device should only be resorted to when in extremities, as on the one hand it is very bad to discharge a battery too low, and on the other hand it is bad for a coil to work it with too high a voltage. The batteries should not be worked below 3·7 each, and coils are constructed to work at a voltage of from 4·4 to 5 volts; so that if the

two cells were down even to 3·3 each this would give 6·6 volts for the coil, which might be too much for its internal economy.

But to return to the two accumulators. The double wiring we have described is not in practice made complete throughout; two wires will be employed for connecting directly either to the battery or to the coil, but the other pair of wires will lead to the switch from which a single wire will proceed to the coil or battery as the case may be. The switch is so constructed that by moving the handle to one or other of the extreme positions the corresponding battery will be connected up, while the other will be disconnected. When the handle is in the intermediate position, both batteries will be cut out and no firing can take place.

Hitherto we have spoken for simplicity's sake almost entirely of the ignition for a single-cylinder engine, but when there are two or more cylinders it will be obvious that some complication is necessary. The contact breaker must provide for a make and break at the right time for the firing in each cylinder, but as to the coil, one has a choice either to use a separate coil for each cylinder, or to use one coil and then employ a device for distributing the high tension current to each plug in turn. The latter is the better arrangement theoretically and will probably survive the other, as the practical difficulties in the way are not insurmountable.

When separate coils are employed the respective primary circuits are connected up to the

respective contact blocks or blades (as the case may be) in the contact breakers, and separate high tension wires lead from the respective coils to the corresponding sparking plugs. The coils are generally made up together in one box, and a single earth terminal is frequently used for all of them. Where trembler coils are employed, as is usually the case, care must be taken to adjust them equally to produce regular firing in the different cylinders of the motor.

In the case of a single coil, the high tension wire leads to the distributing device, which is similar to an internal wipe contact breaker. The high tension current is led by a wire from the coil to a rotating arm, the outer end of which carries a block, roller or the like. This bears against the interior of a circular track into which are set a number of metal blocks. These blocks, in turn, are in electrical connection with suitable terminals from which separate high tension wires pass to the respective sparking plugs. In every case there must be the primary make and break to induce the secondary current at the moment each spark is required, and it is left to the distributer to conduct the secondary current to the proper sparking plug. In some distributers wear is avoided, and an intensifying effect obtained at the same time, by dispensing with the rubbing and making the rotating arm just too short to reach the respective contacts. In this case the current will jump the gap between the end of the arm and each contact in turn, the jump being attended by a spark as usual. Should the spark

fail to occur at any one or more of the contacts, one will know at once not only that the ignition is defective, but in connection with which cylinder the defect exists.

Referring to the timing of the engine, it should be remembered that the propagation of the flame in the compressed gas is not absolutely instantaneous; so that in order to produce the maximum explosive effect at any particular position of the piston, it is necessary to cause the spark to fire at a certain interval before the piston reaches that position. For firing at a moment when the piston has reached an earlier stage in its movement, the contact breaker must be adjusted to act at a correspondingly earlier period of time; and the contact breaker is advanced for quick running and retarded for slow running, to provide the proper interval for flame propagation in each case.

Dual Ignition.

A large number of cars are fitted with two sets of electrical ignition apparatus. The two are generally combined to a greater or less degree and are then known as Dual Ignition. The battery and coil usually form one part of the system, of which examples are described further on in the book.

The Delco System

is of American origin and is fitted, together with the Bosch high tension magneto, to some

Cadillac cars sold in this country. The system comprises—a 10-volt battery, generally of six dry cells; a coil box containing four plain coils (for a four-cylinder engine); a distributer for bringing each coil into operation in turn; two switches, one for testing by cutting out the cylinders one at a time, and the other for utilising the Delco or the Magneto system as required; and lastly a Relay which serves instead of an ordinary contact breaker.

The four coils have a single or common connection between their primary windings and the positive terminal of the battery. The respective other ends of the primaries are connected to the corresponding terminals of the distributer and thence *viâ* earth to the main switch, and on through the relay to the negative terminal of the battery.

When a current is sent a long distance it is sometimes so weakened by leakages that on reaching its destination it is unequal to perform its main object, say, to ring a telephone bell. When this is likely to be the case a relay is employed. The relay is an electro-magnetic switch, which, when actuated, connects up a strong local battery or other source of current, and which includes the telephone bell or the like in its circuit. Hence, the main current accomplishes the ultimate object of ringing the bell by the indirect means of exciting the electro-magnet of the relay by traversing its coils.

The Delco controlling relay is constructed on somewhat similar lines and serves the same purpose

as a single trembler for a magazine of coils, but it gives a single break and a single spark instead of a series, on each occasion, and hence uses a minimum of current, which makes possible the use of dry cells instead of secondary.

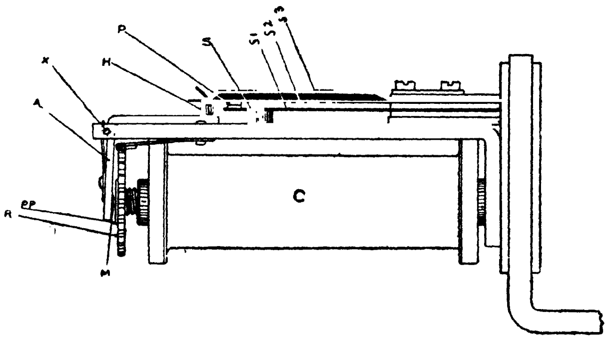

Fig. 19.—The Delco Relay.

Each time the distributer makes contact a current is sent through the winding of the electro-magnet C. The magnetised core (which terminates in a finely threaded screw PP) then attracts the end A of the bell-crank armature which is pivoted at X. The other end H of the armature simultaneously lifts the spring S2, thus separating the platinum points P and breaking the circuit which passes through S2. The armature A would now be released from the core PP and the relay would operate as an ordinary trembler were it not for a fine additional winding on the electro-magnet, which secondary winding is "shunted" around the points P. Thus, the magnetic action of the core

is maintained sufficiently to hold the armature still in place until the distributer arm has left the segment, and the secondary winding of the electro-magnet is discharged, releasing the armature and leaving it ready to make another single break. S and H are studs of hard insulating material, and the spring S3 helps to hold the platinum point on S2 in contact with the corresponding point on the stationary blade S1. R is a ratchet by which the screw end of the core may be adjusted for wear in course of time A press button on the switch serves to cut out the secondary winding of the relay allowing the relay to operate as a trembler when a stream of sparks is required as at starting.

In a modified arrangement the Cadillac ignition comprises a complete battery and coil system with single plain coil and contact breaker, in addition to the magneto. In this case the relay is employed only as an accessory to the battery system, serving to provide the series or shower of sparks for starting on the often weakened mixture that remains in the cylinders after a long rest.

The Lodge Ignition.

Before leaving battery and coil ignition, mention must be made of Sir Oliver Lodge's ingenious system. It depends upon the principle of induction associated with the condenser, and more particularly with the well-known Leyden jar. If a thin sheet of glass be coated with tin-foil conductors on both sides—leaving wide "surrounds" of bare glass beyond the edges of

the tin-foil "carpets"—and one side of the glass be electrically charged "positively," the other side will, by induction, be charged negatively to a corresponding degree of electrical pressure.

In the Lodge coil the two ends of the high tension winding are brought to a pair of sparking points arranged in the coil box, and the same two ends are also connected to the conductors on the one side of two glass plates. From the conductors on the other side of the glass plates connections are made to the central electrode of the sparking plug and to earth, in the usual way.

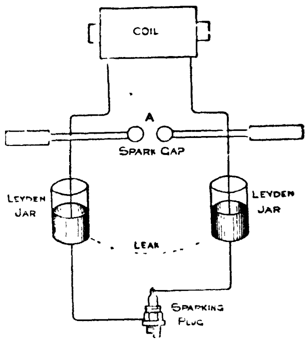

Fig. 20.—The Lodge Ignition.

When the high tension current is induced in the secondary winding of the coil the one side of the plates are charged positively and negatively respectively, and when as full as they can hold, the electrical balance is restored by a spark jumping the gap between the points in the coil. But the charging of the one side of the plates is accompanied by a corresponding charging by induction of the other side thereof—negatively and positively respectively. A conductor of moist blotting paper or other small efficiency equivalent is arranged between the tin-foils on this other side of the plates to keep them at equal electric pressure except at the moment of discharge.

The discharge of the one side of the plates releases the induced charges on the other side thereof and is accompanied by a spark at the plug, such spark having the suddenness characteristic of the spark obtained from a Leyden jar, and though really in the nature of an oscillation or shudder, its flash occupies but a fraction of the time taken by the spark obtained with the ordinary coil system.

In fact, the speed of the discharge is so great that the current chooses the short distance between the points rather than take the longer though easier course afforded by, say, the carbon which sometimes deposits on the insulation of the plug if the engine be run with too strong a mixture or too much lubricating oil. This B spark, as it is called, to distinguish it from the ordinary A spark, appears to produce combustion in a particularly effective manner, much as a snatch at a cord will break it when a steady pull will not.

The coil or igniter is built on the trembler system, and in some patterns is made with two tremblers, either of which can be switched into action as required. Another switch provides for reversing the direction of the current, thus enabling one to guard against pitting of the platinums of the trembler. The switches and A spark gap are visible through windows in the coil case. The secondary winding instead of being one long spool is constructed like a series of reels of cotton strung on a rod; this arrangement reduces the risk of breaking down the insulation.

CHAPTER III.

The Low Tension Magneto System.

ONE outstanding advantage of the magneto system is that the motor generates its own electricity. The necessary expenditure of power is very small ; indeed the efficiency of the engine often appears to be increased when the accumulator is replaced by a magneto. While it is always certain that an accumulator will require re-charging sooner or later, even though it is not in active operation, the time when it will have to be revived is extremely uncertain. We have had a battery full one day and as dead as a door nail the next morning, for no apparent cause—and, of course, miles from a charging station. The horseshoes of a magneto are so far permanent magnets that, properly treated, they seldom require to be re-magnetised.

High tension magneto ignition corresponds to the accumulator and coil system as described in the preceding chapter in that there are in both a source of electricity, a contact breaker, an induction coil or transformer, and a sparking plug with separated points. There is no system of low tension accumulator ignition in general use in this country, but low tension magneto ignition corresponds to a battery and a contact breaker with primary circuit only, the principal differences being that a magneto is substituted for the accumulator, and (in order to get the spark at the

right place) the contact breaker is enclosed in the combustion chamber of the motor. Only one wire is required, viz., that running from the

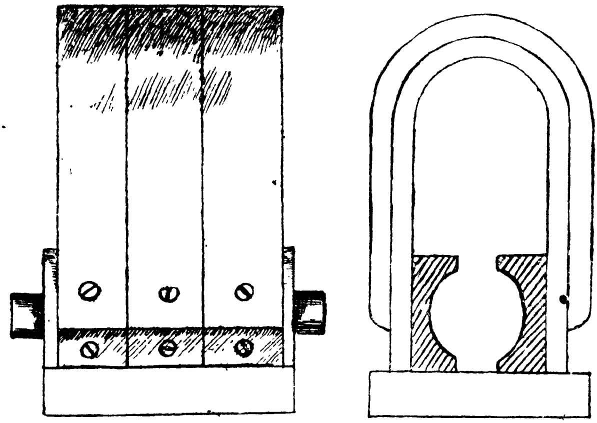

Fig. 21.—Side and End Views of the Magnets.

magneto to the contact breaker, the circuit being completed by earth, so the risk of short circuiting is reduced to a minimum. In practice a single, bare copper wire is sometimes used, as air is a non-conductor, and there is little risk of the wire touching anything between the two terminals. Still an insulated stranded wire is preferable.

As we have already seen, when a conductor is passed through the space between the ends or poles of a magnet, a current of electricity is generated in the conductor. The conductor cuts the lines of force which pass across from the north pole to the south pole of the magnet, and

the more lines of force that are cut in a certain time the more intense will be the current generated in the conductor. Hence the faster the machine works the higher the voltage. This is apt to lead to difficulties in the practical application of magneto ignition to motor-cars, because if the apparatus be constructed so that the speed at starting is sufficient to provide a proper spark, the voltage might easily rise too high for the insulation to withstand when the car was running at normal speeds.

One way of combating the difficulty is to use a permanent magnet instead of the electro-magnet of an ordinary dynamo, as the former is very much less influenced by the speed than the latter. At the same time it must be confessed that with some magneto machines it is difficult to obtain a good spark when rotating the crank-shaft with the starting handle, and in many cars accumulator ignition is fitted as well as magneto, not only with the object of having a reserve system of ignition at hand in case the magneto breaks down, but in order that the spark may be easily obtained when starting.

In some magnetos the tendency for the voltage to rise too high when the engine is running fast is checked automatically by the breaking of the circuit occurring relatively earlier in the magneto's cycle, and hence before the current is fully developed, as we shall see later.

As the efficiency of a permanent magnet is largely in proportion to its surface, it is usual to employ, say, half a dozen horseshoes instead of

only one large one. The six horseshoes are arranged in two sets of three each, the one set being fitted over the other. They are all disposed with the north poles at one side and the south poles at the other, and they are secured together on a common base, thus forming a kind of tunnel. On the inside of the poles are fixed soft iron grooved bars called pole pieces. The two grooves are set concentrically to form a cylindrical chamber, which is closed at the bottom by the base and is open at the top. At each end of the cylindrical chamber is secured a vertical

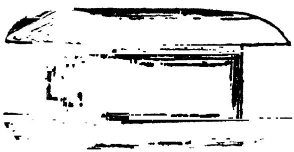

Fig. 22.—The Armature without Coil.

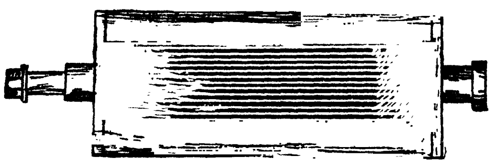

Fig. 23.—Armature, with Winding, End Plates and Spindles.

plate of brass or other non-magnetic material. These plates are provided with bearings adapted to receive the armature spindle.

The armature is of modified cylindrical formation, and is adapted to rotate in the cylindrical chamber between the pole pieces. Referring to the illustration, Fig. 22, it will be seen that the armature departs from the cylindrical form in that

it has two deep longitudinal grooves arranged diametrically opposite to one another, and these grooves are connected by tranverse grooves at the ends of the cylinder. Hence, both in end elevation and side elevation, the armature represents roughly the letter H. The two segmental portions of the armature are known as the "cheeks," and the part connecting them, corresponding to the cross-bar of the letter H, may be described as the "body." The grooving of the armature is done with the object of providing accommodation for a coil or winding of insulated wire, which is wound round the body until the grooves are filled up, and the cylindrical form of the armature is thereby nearly restored. It will be easily understood that if the armature with its winding be inserted in the cylindrical chamber between the pole pieces and be rotated therein, that the longitudinal parts of the coil will cut the lines of force extending from the one pole piece to the other, and that the effect will be the generation of a current of electricity in the coil.

But from the nature of the design of the armature, the way in which it can be mounted and rotated is not at once obvious; there is nothing in the nature of a spindle extending from end to end. But the spindle is only required to exist at the ends, and these ends are provided by securing discs to the ends of the armature, the discs being formed with short spindles or stud axles projecting from their centres. The discs are made of non-magnetic metal so as not to interfere with the action of the apparatus, and

the stud axles are located in the bearings in the vertical plates above mentioned. The ends of the spindles project through their bearings, and to one of them is secured, say, a spur-wheel by which the armature may be rotated at a speed having a positive and constant ratio to that of the motor.

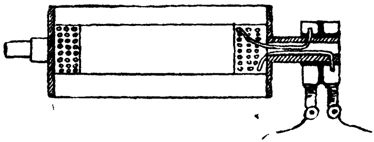

Fig. 24.—Armature with Ring Commutator and Brushes.

But now that the armature is rotating and the coil is cutting the lines of force, another little difficulty presents itself. The current of electricity is in the coil, no doubt, but how are we to get at it? The "way out" is simple and ingenious. One of the spindles is made hollow, and through this the ends of the wire may be led, and secured to two rings fixed to the spindle, but insulated therefrom and from each other. Now, if spring blades or "brushes" be caused to bear upon the respective rings the current will pass to the blades, and thence by suitable terminals to any other points we like. If one of the ends of the coil be secured to the armature it will be earthed through the armature and other metal parts of the machine.

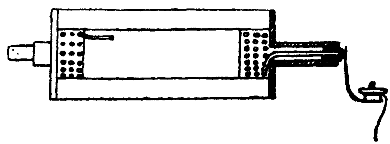

Fig. 25.—Armature with Winding earthed at one End.

In this way we can dispense with one of the rings. For the other ring we can substitute, if preferred, an insulated terminal arranged concentrically at the end of the spindle, and, in this case, the blade will be arranged to bear against the terminal co-axially instead of circumferentially.

Now it will be obvious, from the arrangement of the armature, coil, and pole pieces, that the cutting of the lines of force will be greatest when the coils are moving most nearly in a vertical direction, that is when at right angles to the lines of force. The current will be at its maximum about this time. As the armature turns through the next 90 deg. the parts of the coil will travel in a direction more and more nearly parallel to the lines of force, so that when the body of the armature is horizontal practically no lines of force will be cut, and the current will have dropped to zero. In this position the armature forms an excellent conductor for the lines of force and they pass therethrough, avoiding the coils. Further, the lines continue to flow through the armature while the latter is turning through quite a considerable angle from the horizontal. Indeed they seem to pursue this path until the cheeks are just leaving the top of the north pole piece and the bottom of the south pole piece, when it becomes easier for some of them to travel right across through the upper cheek and the others through the lower cheek. And as the lines of force thus change their course, they rush in directions transverse to those of the two sides of the coil. The results are the very rapid cutting of a large

number of lines of force, and the generation of a relatively strong current in the coil. Thus the current attains two maxima and two minima in each revolution of the armature. But the part of the coil that goes upwards for the first maximum is going down when the second is reached, and the part that was going down goes up, so that the lines of force are cut in the opposite direction, and accordingly the current travels the reverse way through the coil. The reversal takes place twice in the revolution, and the current is said to be an alternating one.

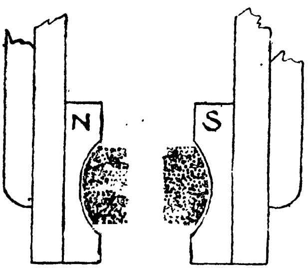

Fig. 26.—Section of Magneto showing Coils in Horizontal Position.

But we must not forget our pledge. The explanation we have given of the action of a magneto is highly orthodox, but it is at least doubtful whether it is really anything better than a good working analogy.

If one dips a rotating wheel into a liquid, some of the liquid adheres to the rim and is carried up a distance, which is greater or less according to the viscosity of the liquid and other conditions. In ideal circumstances no adhesion would take place, the liquid would part company with the rim as each point thereon rose above the general level of the liquid. But in practice adhesion does take place, and the faster the

wheel is rotated the further up will the liquid be carried before it falls away. Similar dragging action is noticeable in a magneto. The maximum voltage is obtained more or less later than the ideal moment, and the faster the armature is rotated the greater is this "lag." The lines of force would seem to be distorted, being dragged round to a greater or less degree by the armature. The contact breaker is almost always operated by the engine, and thus breaks the circuit (apart from any positive timing arrangement) at a certain position of the armature without being affected by the lag. Hence, at higher engine speeds the lag causes the circuit to be broken at a relatively early period in the magneto's cycle, and the ignition is automatically retarded. This automatic action is overcome by providing positive means for timing the contact breaker on the engine. But it will be observed that advancing the spark in this way involves breaking the circuit before the current has reached its maximum. Fortunately the rise of voltage attending increased speed of the engine, and hence of the armature, sufficiently (and probably more than sufficiently) counterbalances the lowering of the voltage due to breaking the circuit before the maximum is reached. The higher the speed, the greater the available range of timing, due to the greater voltage, but discounted by the lag causing the break to be made earlier in the magneto's cycle.

The contact breaker must be set to operate at a maximum position of the magneto when the armature is turned at a low speed (allowing for

only a slight lag), so that the best available spark may be obtained for starting the motor.

Having described how the electric current is generated by the magneto we will now consider the other part of this system, viz., the contact breaker. As the spark is to be produced in the cylinder the "points" of the contact breaker must also be within the same, while the actuating mechanism is outside. This introduces the weak point of the system—the necessity for a moving spindle passing through the cylinder wall. It will be obvious that, unless a very good joint is made and subsequently maintained, there will be a leakage of compression through the spindle passage and a consequent loss of power. Long experience, however, has done much to enable makers to meet the difficulty, and with reasonable attention little trouble is now encountered from this feature. The spindle and passage are made like a valve, so that the pressure in the cylinder helps to keep the joint tight. The joint itself is carefully ground in, and nuts or a spring provide adjustment for wear.

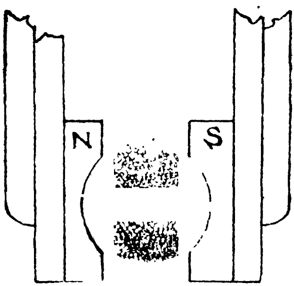

Fig. 27.—The Coils in the Vertical Position.

The wire from the magneto is connected to the outer end of an insulated pin screwed tightly into the cylinder wall. The inner end of this

pin forms one of the contact points. The other point is on the end of an arm fixed to the inner end of the spindle. On the outer end of the spindle is another arm which is held up by a spring, so that the contact points are normally held closely in contact. At such times the current generated by the magneto passes along the wire to the insulated pin, from the pin to the contact arm and taper spindle, and so to the earth of the motor and back to the earthed end of the armature winding.

The spark is obtained by suddenly separating the contact points while the current is flowing through this circuit. This is accomplished by knocking down the end of the outer arm, and so lifting the end of the inner arm away from the insulated pin. As the end lifts the current continues to flow for a moment from the pin and so produces the spark.

The knock is administered to the outer arm by a tappet fixed to a vertical rod. The rod is furnished with a strong spring tending to drive it downwards, but it is held up most of the time, so that the tappet clears the outside arm, by a cam rotated at a suitable speed by the motor. The foot of the rod is provided with a roller

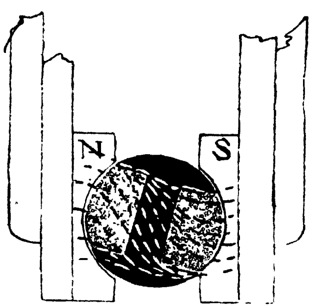

Fig. 28.—How the Lines of Force are cut.

which bears on the periphery of the cam. The cam is of the notched type, and when the notch in it comes under the roller it allows the rod to be depressed sharply by its spring, so that the tappet strikes the outer arm and lifts the inner arm of the contact breaker.

The armature of the magneto and the cam of the striking mechanism are driven positively by

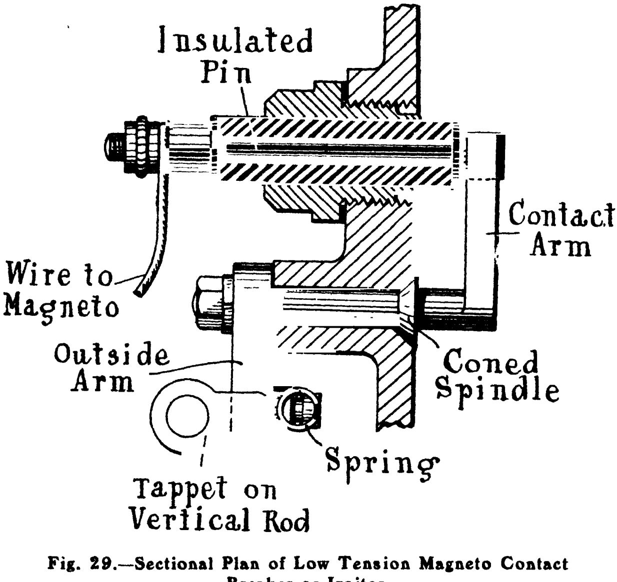

Fig. 29.—Sectional Plan of Low Tension Magneto Contact Breaker or Igniter.

the engine, and the timing is such that the contacts are separated and the spark produced when the armature is at about one of its maximum

positions, and when the piston is at about the top of its compression stroke.

To vary the timing one can merely provide for altering the moment when the contact points shall separate relatively to the position of the piston, but it is better that the magneto should be simultaneously regulated so that the armature will have its maximum positions timed to occur always at the moment of breaking contact, whenever that may be.

The magneto and contact breaker we have described are not those of any particular maker, and have been set forth merely to make plain the principles of our subject. In fact the low tension magnetos at present on the market, and which we will now proceed to deal with, frequently differ more or less from our typical specimen.

The Simms and the Bosch.

The best known of the low tension magnetos are the Simms and the Bosch. They are constructed with horseshoe magnets and H armature, but some patterns are remarkable in that the armature is fixed. The necessary moving member takes the form of a shield which is introduced between the armature and the pole pieces, and just clears both. The shield is like a hollow cylinder with two opposed sections, of about 90 deg., cut away. The remaining parts are held in position by end discs, and these discs have axial sleeves projecting from them. The shield encloses the armature, the axial sleeves on the

shield fitting over the stud axles on the ends of the armature. The sleeves of the shield form stud axles for the shield and are mounted rotatably in the end plates fixed to the magnets. Thus the end plates support the shield, and the shield sleeves support the armature. The stud axle on one end of the armature projects through one bearing and is locked in such a position that the body of the armature is held vertical; and the sleeve on the other end of the shield projects through the other bearing and carries a wheel or an arm by which the shield is worked. The shield is now generally rotated, but it used to be oscillated through about 90 deg. The rotary movement is obtained by means of chain, or better spur, gearing.

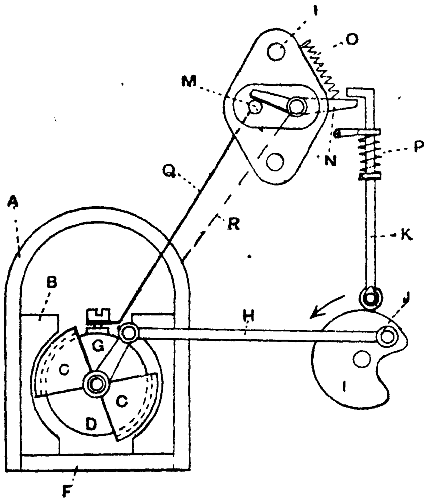

Fig. 30.—Simms or Bosch Low Tension Magneto System with oscillating Sleeve.

A, magnets; B, pole pieces; C, end pieces of sleeve; D, stationary armature; F, base; G, terminal; H, connecting rod; I, cam driven by motor; J, eccentric pin on cam; K, tappet rod; M, terminal on contact breaker; N, contact breaker lever; O, spring to close contacts; P, spring on tappet rod; Q, low tension wire; R, earth return.

Now whether the shield is oscillated or is rotated it is found that the number of maximum positions is doubled, the same occurring both when the solid parts of the shield are horizontal

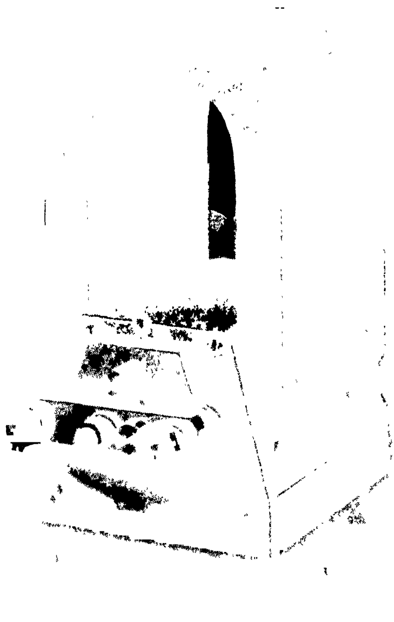

Fig. 31.—Simms Low Tension Magneto.

and when they are vertical, and the zero-positions are intermediate thereto. The reason for this appears to be that at the intermediate positions

the shield serves to conduct the lines of force into one end, *i.e.*, top or bottom, of the armature body and out of the other; while at the horizontal and vertical positions of the shield, the lines are not able to take this course between the poles and are cut by the moving shield. As there are four instead of two maximum positions, this magneto is run at half the speed of others. Mechanically the rotary action is to be preferred to the reciprocating or oscillating. The contact breaking mechanism in this system is very similar to that already described, but the parts are mounted on a plate, so that the whole may be secured in position as a unit. When the plate is detached from the cylinder the contact points can be inspected *in situ*.

One great advantage of the stationary armature is that the current does not have to be collected through any rotating parts. All that is necessary is to earth one end of the winding to the armature and to carry the other up to a conveniently situated insulated terminal. This terminal is connected with that of the insulated pin of the contact breaker by a single wire, which can be a bare wire if it is hung clear of metallic parts.

The Albion.

In the Albion low tension magneto ignition system, instead of the armature or a shield rotating, the armature is fixed and the magnets

rotate. Further the magnets and the armature both differ from the horseshoe and H or shuttle forms we have previously considered. The magnets are of bar form and are fixed to a bronze frame which is secured to part of the crank-shaft of the motor. Both the north poles of the magnets are arranged at one end, and the south poles at the other. To the back of the ends of the magnets are secured the pole pieces which are curved concentrically on their opposing faces. The armature is of nearly circular form, the gap separating the ends being rather less in length than either of the curved faces of the pole pieces. The armature itself is laminated, *i.e.*, built up of sheets of soft iron, and these sheets are insulated from one another. Armatures are frequently constructed in this manner with the object of reducing self-induction, which tends to upset the action they are desired to produce. The armature as a whole is bolted to the motor

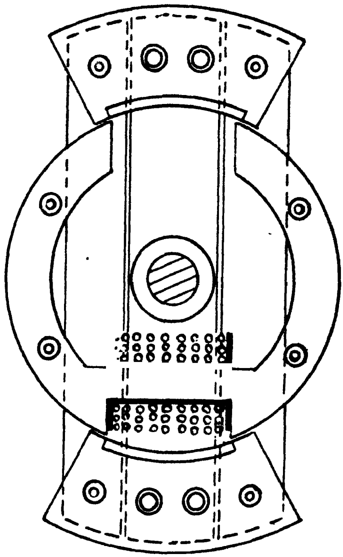

Fig. 32.—The Albion Low Tension Magneto.

casing. Opposite the gap the armature is cut away somewhat and the coil is wound round this reduced portion. The armature stands in the plane of the pole pieces, and as the magnets rotate the lines of force cut the winding of the coil and so produce the electric current. The coil circuit is closed when the magnetic flux through the armature core is a maximum and it is broken when at or about a minimum and is not again closed till it has again risen to maximum, with the result that the magnets are thereby slightly charged and their power maintained.

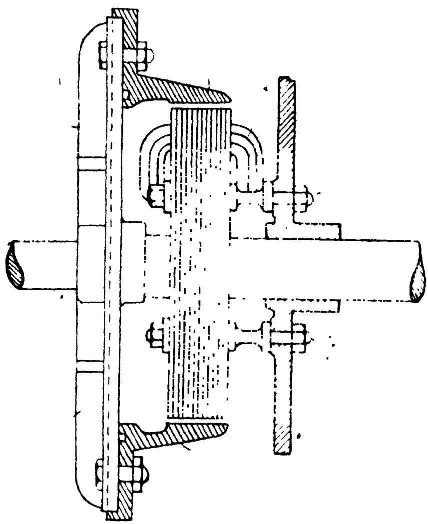

Fig. 33,—Side Elevation of the Albion Low Tension System.

This magneto is employed in connection with a two-cylinder motor. The one end of the armature coil is earthed and the other is connected to an insulated bar fixed on the motor. From this bar the current is transmitted to the insulated pins of the contact breakers, or 'igniters,' as these parts

are frequently called in low tension magneto ignition.

Normally, the moving arm is held just out of contact with the fixed pin by the strong spring

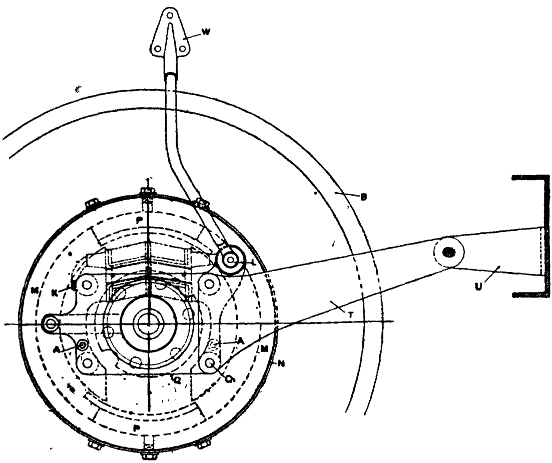

Fig. 34.—The 24-30 h.p. Albion Magneto.

A, locating screw for armature spider; B, flywheel; C, extension of crank-shaft; D, flange on crank-shaft; E, bolts securing magneto drum to crank-shaft; F, ball races supporting armature on extension shaft; F1, grease cup for ball races; G, sleeve on extension shaft, carrying ball races; H, armature; J, armature spool; K, earthed end of armature coil; L, live end of armature coil; M, semi-circular magnets; N, phosphor bronze drum; P, magneto pole pieces: Q, armature spider supported on ball races F; R, dog clutch, transmitting drive to propeller shaft; S, spring washer locating sleeve G; T, arm preventing rotation of armature; U, lug carrying arm T; V, insulated cable from magneto to engine; W, cable holder; X, dust guard.

acting on the tappet, but the scroll cam lifts the tappet just before the moment of ignition and so allows a light spring to bring the platinum points into contact. Then the tappet rod drops over the shoulder of the cam and the spark occurs at the points as the tappet strikes the moving arm.

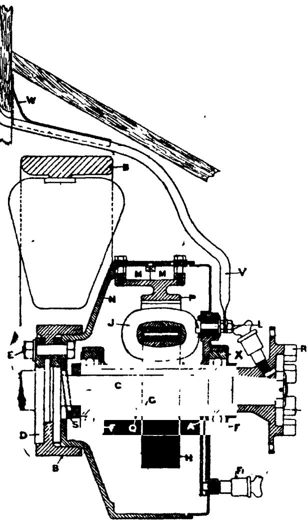

Fig. 35.—Section of the 24-30 h.p. Albion Magneto.

The striking mechanism is very similar to that already described, but the contact points are provided with platinum tips to prevent corrosion.

The tappet is made as a buffer to reduce noise, and the rod by which it is carried is operated by a scroll cam. Timing is effected by altering the

position of the foot of the rod relatively to the cam, but is not directly under the control of the driver. Like the other controls on the Albion car, it is regulated automatically by the Murray governor.

The four-cylinder 24–30 h.p. Albion cars have a low tension magneto placed behind the flywheel. It is on the same principle as that fitted on the two-cylinder 16 h.p. cars, the only essential difference being that the magnets are semi-circular instead of straight and are carried inside a bronze drum attached to the flywheel. As before, the magnets revolve with the engine and the armature is stationary and rests on ball-bearings on an extension of the crank-shaft.

The striking mechanism is similar to that on the two-cylinder model but the timing gear is somewhat different. As the speed increases, the governor pushes along the cam-shaft and, owing to the spiral shaped cams, causes the ignition to take place earlier.

CHAPTER IV.

The Dynamo, Accumulator and Coil System.

ANOTHER way of using the low tension magneto is in conjunction with an accumulator and coil, etc. The magneto is then adapted to operate as a mere dynamo generating a current for feeding the cells and keeping them fully charged.

This is an attractive scheme on paper as it removes the principal objection attaching to the secondary battery, viz., that of giving out at the most inconvenient moments, the failure involving removal for re-charging purposes. In practical use, however, there are certain difficulties and objections. The voltage of the current delivered by a dynamo depends largely upon the speed at which it is run, and as the revolutions per minute of a motor-car engine vary from, say, 100 at starting by hand to 2,000 or more when running all out, it is by no means easy to design a dynamo that will not buckle the plates of the cells by charging too fast, on the one hand, and will not allow the accumulator to discharge itself through the dynamo when the speed is low, on the other. Automatic switches which cut out the dynamo when the cells are fully charged, and only cut it in when the armature has reached a certain speed of revolution have to be devised, and a great deal depends upon their satisfactory

working. The positive switches under the control of the driver must also be operated intelligently. There are also mechanical difficulties, such as overloaded bearings, to be considered, and until recently the system appeared to have had its day.

Interest has now been revived in the matter, not so much from the ignition point of view, but

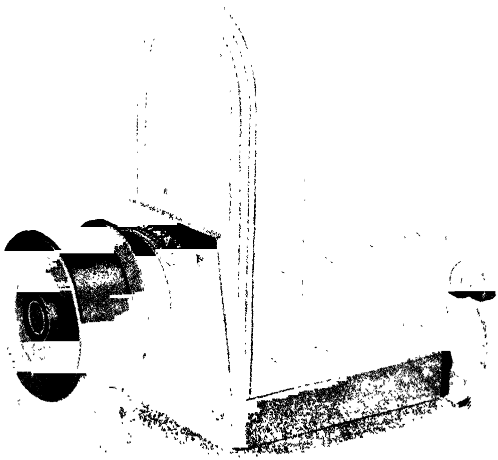

Fig. 36.—The Mira Magnetolite.

on account of the practice of lighting cars—especially of the enclosed types—electrically. It is practically necessary to work through storage batteries, and, as the demand on these is considerable, it is very desirable to feed them as one goes along.

The Mira Magnetolite

is a small electric generator designed for use in this way. The magnets consist of 12 units arranged in 3 sets. The armature is of laminated soft iron and runs in ball bearings. The use of permanent instead of electro-magnets tends to even production of current, and the machine is adapted to deliver its current when running at speeds between 800 and 3,000 revolutions per minute. An ordinary magneto delivers an alternating current but this is quite useless for charging accumulators (unless a rectifier be employed), so the armature is provided with an 8-part phosphor bronze commutator delivering a one-way or direct current.

As the generator does not effect or affect the ignition directly there is no need to drive it at any precise ratio relatively to the engine, and a belt drive is to be preferred to either chain or spur gearing.

CHAPTER V.

The Low Tension Magneto with Coil System.

WE have now dealt with the magnetos which correspond to that part of the accumulator system consisting of the battery and contact breaker with their connections, and producing a low tension spark. Next we will describe the magnetos that correspond more fully with the accumulator system in that they comprise also an induction coil and a sparking plug, and produce a high tension spark.

The Fuller.

One of the most noteworthy points about the Fuller magneto is that it is an all-British production, being made by Messrs. Fuller and Son at their works in Wick Lane, Old Ford Road, Bow.

The casual observer might well be excused for calling this machine a high tension magneto, for as no separate coil is employed it certainly presents the appearance of being a true member of that species. However, though the apparatus produces a high tension spark, it does not do so by means of a double winding on the armature, but by means of a separate induction coil tucked away in the arch of the magnets.

There are three single magnets arranged tunnel-wise, and to these are fixed the channel-shaped pole pieces, which are in turn secured by

vertical screws to the brass base. The armature is of H section with laminated centre and solid ends, the three sections being secured together by longitudinal bolts which also hold the non-magnetic end discs carrying the two stud axles

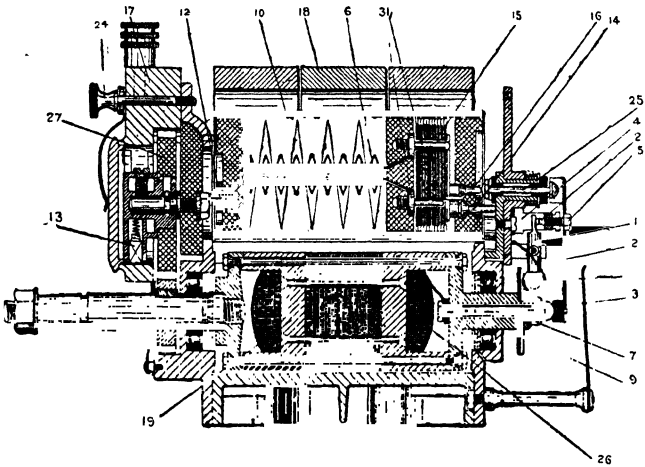

Fig. 37.—Fuller Magneto with Coil.

1, insulated pin; 2, brass arm; 3, carbon brush; 4, insulated bracket carrying contact screw; 5, contact screw; 6, primary winding of transformer; 7, contact breaker arm; 9, disc cam; 10, ebonite transformer case; 12, H.T. spring plunger; 13, carbon brush; 14, spring plunger; 15, condenser; 16, spring plunger; 17, distributer; 18, magnets; 19, armature; 22, platinum points; 23, brass D. washer; 24, bolt to hold distributer; 25, insulated pin; 26, low tension winding of armature; 27, fibre wheel of distributer; 31, condenser bolts.

which constitute the armature shaft. The armature is wound with a single coil of primary wire, one end of which is earthed to the frame through the armature body. The driving stud axle is solid, but the other is hollow and is bushed

at each end with ebonite to insulate a pin located therein. The live end of the primary wire is secured to the inner end of the pin, the outer end of which is formed as a hemispherical terminal. The armature shaft is carried in ball bearings,

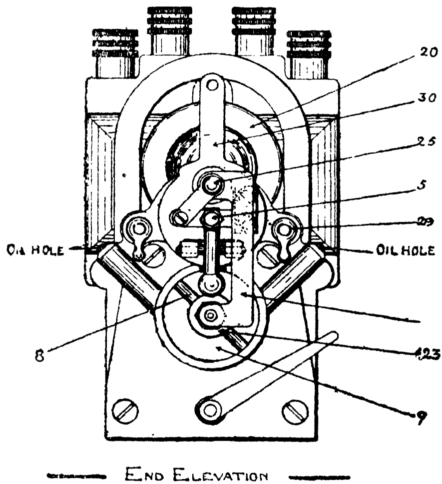

Fig. 38.—End View of Fuller Magneto.

and is generally rotated at the same speed as the crank-shaft.

The primary current is collected from the insulated terminal on the end of the armature by a carbon block mounted on a brass blade spring which is in electrical connection with the fixed platinum point of the contact breaker and

also with the condenser and the induction coil of the transformer. The contact breaker is operated by a cam fixed to the end of the armature shaft. The cam consists of a disc having a diametrical rib across its face. The moving platinum point is mounted on the upper end of a vertical pivoted lever, the lower end of which is furnished with a fibre-roller and is pressed into contact with the face cam by a spring. The bracket in which the lever is pivoted is carried by a plate which is rotatable through a certain angle for timing purposes. So long as the platinum points remain in contact the primary current generated by the rotation of the armature winding in the magnetic field is short circuited, but when the rib on the disc strikes the lever and separates the points (as it does at the two points in the revolution of the armature when it is about its maximum position) the current is then suddenly diverted along to the end of the brass blade, where it makes contact with the head of another insulated pin the foot of which is connected up to one end of the primary winding of the coil by a spring plunger. The other end of this winding is connected to another spring plunger which bears upon the metal work of the machine and so completes the primary circuit. The rush of current through this circuit induces a high tension current in the secondary winding which is distributed to the sparking plugs.

It will be remembered that in accumulator and coil ignition, the battery, contact breaker, switch, and coil are all arranged in series, so that if any link in the chain be broken there will be

no circuit, and no current will flow. If the battery circuit were kept closed the current would soon be gone, and if the circuit included no resistance such as that offered by the coil, in other words if the battery were "short circuited," its rapid discharge would be attended by serious if not fatal injury. With a magneto, however, it is different; so long as the armature is rotated, current will be generated, and unless some course be provided for it, it will endeavour to force one for itself, probably with the result of breaking down the insulation of the armature winding and putting the machine out of action.

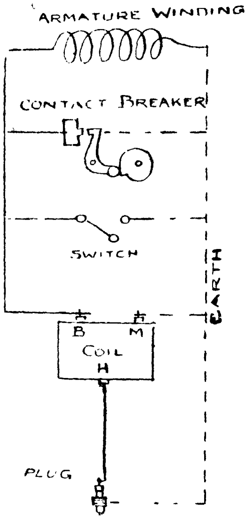

Fig. 39.—Diagram of the Fuller Magneto Ignition.

In the Fuller magneto, therefore, the armature, the contact breaker, the switch and the coil are all arranged in parallel, as shown in Fig. 39. From this it will be seen that there is a lead from the armature winding to the coil with connections to terminals of the contact breaker and switch, the other terminals being earthed; also that when the contact breaker and the switch are both closed the current can flow through the contact breaker, the switch, and the coil. All these paths are open to it, but it will avoid the coil owing to the

resistance it offers, and the result will be the same if the switch be opened. But if the machine be driven while the switch is open the current will follow the circuit through the contact breaker and earth until, on the platinum points separating, the path through the coil will be the only one left, and the current will rush through the primary winding, inducing a high tension current in the secondary in the usual way.

Not only, therefore, must the switch be opened (instead of closed as with accumulator and coil ignition) for working, but when the magneto is being driven but not used (as when an alternative system of ignition is in action) one must be very careful to close the switch to afford a permanent path for the current generated. The path through the contact breaker is, of course, only intermittent.

The large amperage of the current generated by the Fuller magneto is not due only to the ample proportions of the armature winding, but also positively to the fact that the winding sets up a certain self-induction when the contact is broken, and negatively to the fact that the generation of the current is not discounted by the resistance of the coil.

A single coil, of the non-trembler type, is used independently of the number of sparking plugs.

The induction coil is mounted detachably in the space under the top of the magnets and the condenser is arranged at one end of it. One side of the condenser is connected to the armature winding by the brass blade and the other side

is earthed, thus in effect making it bridge across the points of the contact breaker.

The coil is enclosed in an ebonite tube with brass end plates. One of these plates carries the two spring plunger contacts above referred to; the other plate carries a similar contact which forms a connection between one end of the high tension winding and the fixed spindle of the distributer. The other end of the high tension wire is earthed.

The distributing gear consists of two wheels, a small one fixed to the driving end of the armature shaft, and another, of twice the diameter, which rotates on the fixed spindle just mentioned. Rotating with the latter wheel, and therefore at half the speed of the armature shaft, is a radial socket, in which is a carbon rod pressed outwards by a spiral spring into contact with an internal circular track. The track is made of insulating material and has metal blocks let into its surface and connected to terminals on the top of the distributer. The blocks and terminals correspond in number with the cylinders and sparking plugs of the engine.

In Fig. 36 a steel ball is shown in a groove in the spindle; the ball is pressed into the groove by a spring to ensure a good electrical connection between the distributing wheel, socket, etc., and the spindle, which is specially necessary as the latter is lubricated through the oil cup visible nearer the end of the spindle.

The distributer and the contact breaker are enclosed by covers normally held in position by

spring tongues. The magneto is well provided with lubricators.

Fuller Dual.

The Fuller Magneto lends itself particularly well to dual ignition, that is, ignition in which the current can be derived at will from either the magneto or a battery of primary or secondary

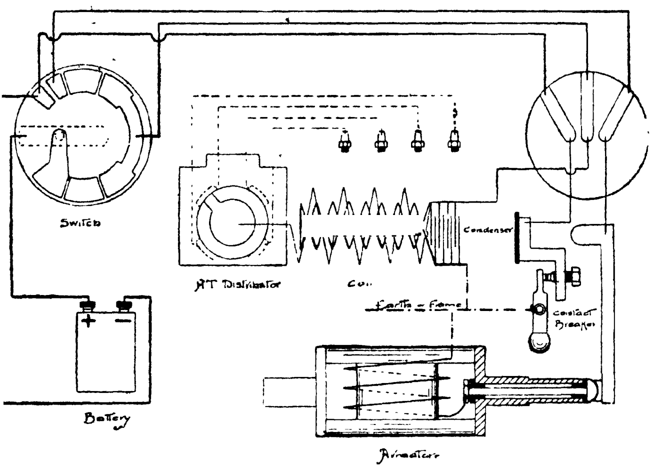

Fig. 40.—Diagram of Fuller Dual Ignition.

cells. In some dual systems separate plugs, cables, distributers and contact breakers are required, besides a switch, coil and battery. But in the Fuller, the coil, contact breaker, distributer and plugs serve for both systems, the switch and battery being the only additions called for. The switch, however, is specially designed to facilitate

starting, or rather re-starting, the existence of a charge of gas, ready to be ignited, in one of the cylinders being presumed in the latter case. If the engine does not fire on moving the switch handle to "Acc." a centre piece on the face of the switch is turned quickly so as to rotate a bar inside the switch. The bar in rotating alternately completes and breaks the primary circuit, and excites the secondary with the usual sparking results.

The Mira.

The Type S.T. Mira magneto differs from the Type S.C. described at p. 168, in that the armature is furnished with a low tension winding only; the primary current generated therein is conducted to a separate induction coil, and the high tension current is led back by another wire to the distributer on the magneto. The makers recommend it for use where the work is specially severe.

The Bosch Magnetic Plug.

An endeavour to secure the advantages attending the use of a fixed sparking plug while avoiding the employment of the elusive high tension current is found in the Bosch magnetic plug. It is an electro-magnetic device and the electricity is generated by a magneto which, though primarily of the low tension type, yet has a double winding on the continuous system adopted in the Bosch high tension magnetos. The

differences between the gauges and lengths of the two windings are not so great in the former as in the latter, however, and they are known as the main and auxiliary instead of the primary and secondary. One end of the main winding is earthed to the armature core, and the

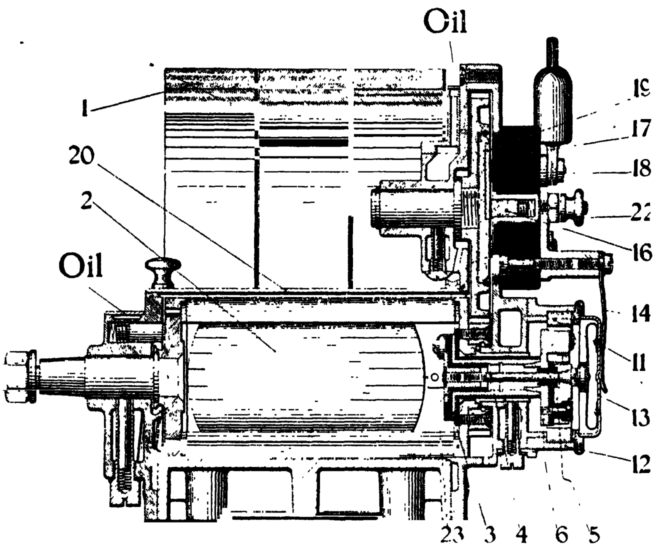

Fig. 41.—Magneto for Bosch Magnetic Plug.

junction of the two windings is connected to the insulated contact piece (3) and hence to the contact breaker disc (6) and bell crank lever (11), which are also insulated. The outer end of the auxiliary winding is coupled up to the blade (5) carrying the stationary platinum screw, by the

pipe nut (23) and central bolt (4), all of which are insulated. The contact breaker itself is like that shown in Fig. 53, and serves to complete the auxiliary circuit while the platinum points are in contact. When they separate the current generated in the main winding is augmented by the extra current in the auxiliary winding, the breaks being arranged to take place at or near the two maxima positions, as usual. This united or reinforced current is employed to operate the magnetic plugs.

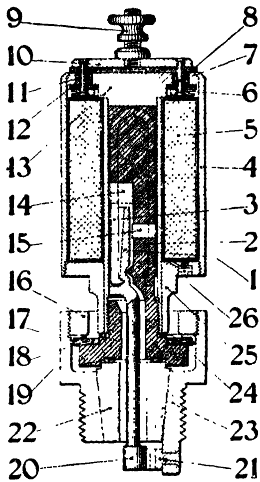

Fig. 42.—The Bosch Magnetic Plug.

The main winding is coupled up to the distributer segment (19) by the brass cap (13) carrying the spring and carbon block bearing on the head of the bolt (4), the blade (14), the brush (16) and the L piece carrying such blade and brush. The distributer is wired to the plugs in the usual manner, except that low tension cables suffice.

The plug itself consists of an electro-magnet the core of which, when energised, attracts an armature which forms the upper end of a lever. Normally, the lower end of the lever is held in contact with a stop at the bottom of the plug, by a light spring. The current is carried through

the contact points, and on their separating the low tension firing spark is produced.

The internal constrtiction of the plug is shown in detail in Fig. 42. The coil (5) is enclosed in the shell (4) which is insulated from the body (23) by the steatite cone (22) and the mica washers (18). One end of the coil is connected to the terminal (9) by the rivets (7) and plate (10), which are insulated with mica at (8), (10), (11) and (12). The other end of the coil is secured to the shell at (26). The pole piece takes the shape of a longitudinally grooved soft iron bar (2) and fits into a tube closed by a disc (13) which constitute a magnet. Near the lower end the pole piece is provided with a transverse knife edge on which is fulcrummed the lever (1). The lower end (20) of the lever has a hatchet head which is pressed into the jaws of a cleft contact piece (21) by a hairpin spring (3) which lies in the groove of the pole piece (2).

When the electric current (as reinforced by the breaking of the auxiliary circuit) is delivered to the plug by the distributer it passes from the terminal (9) through the coil (5) to the shell at (26), and thence to the tubular magnet, the pole piece and the lever, and so *viâ* the contacts (20) and (21) to earth.

But the passage of the current through the coil magnetises the pole piece which promptly attracts the upper end of the lever, the stop (15) preventing actual contact. This movement of the lever breaks the circuit at (20, 21) causing a spark and demagnetising the pole piece and releasing the upper end of the lever.

The spring (3) immediately restores the head (20) of the lever into contact with the stop (21); and these operations are rapidly repeated so long as the distributer continues feeding the plug.

Although the magnetic plug belongs to the Low Tension Magneto System its action may be better understood after studying the High Tension Magneto System.

The Brooks Magneto.

This recently introduced magneto is another example of the low tension generator and independent coil type. As in the Fuller, the coil is housed in the arch of the magnets, but it is principally distinguished in other respects by its differences from any other machine on the market.

There are three pairs of special tungsten steel magnets mounted on a base, and closed in at the ends by plates of non-magnetic metal. In addition to the usual pole pieces there are a pair of pole faces let into the walls of a light hollow cylinder which fits snugly into the tunnel and turns with the contact breaker in timing the ignition. The object of this is to, in effect, advance and retard the lines of force along with the sparking, so that the breaks may always occur at the maxima positions. This should be specially valuable at starting. The main pole pieces are bevelled and are held rigidly in place by casting the base and end plates around them. The moving pole faces are mounted in their cylinder in the same way, and the end disc of the armature

is cast on to the driving spindle, the root of which is squared to ensure a positive joint.

The armature is of the laminated H construction and has two windings, but these are

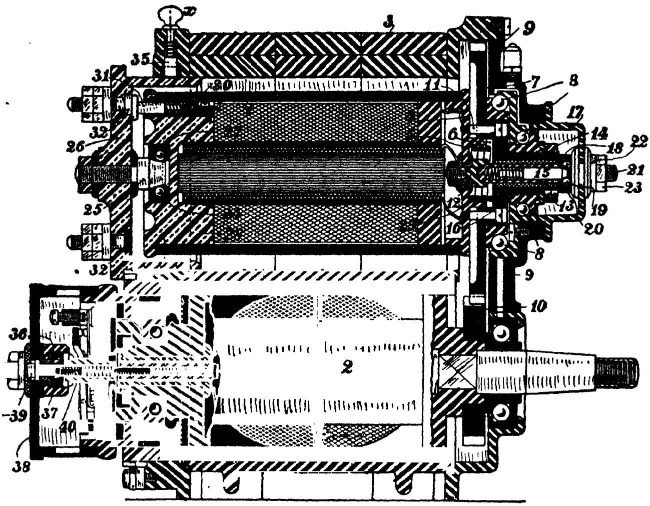

Fig. 43.—The Brooks H.T. Magneto in Longitudinal Section.

1, h.t. coil in vulcanite case; 2, l.t. winding and armature; 3, magnets; 4, driving cheek of h.t. coil; 5, spring to keep coil up to bearing cone (25); 6, recess in gear wheel; 7, driven spur-wheel; 8, ball bearings for coil; 9, removable cap carrying gear wheel and bearings for coil; 10, driving pinion on armature spindle; 11, screws holding coil to gear wheel; 12, insulated stud in end cheek of coil; 13, sleeve containing plunger (15); 14, adjusting nut of ball bearings (8); 15, hardened steel spring plunger (primary winding); 17, brass cover; 18, cup of ball bearing contact; 19, balls in ditto; 21, l.t. terminal from armature (*via* dual switch if used) to h.t. coil; 22, vulcanite insulator on cover (17); 23, terminal nut; 24, ball bearings at distributer end of h.t. coil; 25, coned hard steel stud supporting end of h.t. coil; 26, vulcanite h.t. distributer case; 27, ball bearing cup; 28, vulcanite end of coil case; 30, metallic sleeve containing 31; 31, hard steel distributer contact; 32, hard bronze segments in distributer, 35, socket for locking bolt holding distributer; 36, ball bearing contact l.t. winding; 37, support for fibre rollers; 38, brass cover carrying 36, 37, 39; 39, hard steel ball bearing contact; 40, hardened contact stud.

both primaries, and one is wound right hand and the other left. One end of each coil (or rather, the junction of the two coils) is earthed.

The other two ends are connected to live terminals projecting from the end of the armature into contact with two blade springs mounted on the back of the vulcanite disc (10, Fig. 44), which forms the base of the contact breaker.

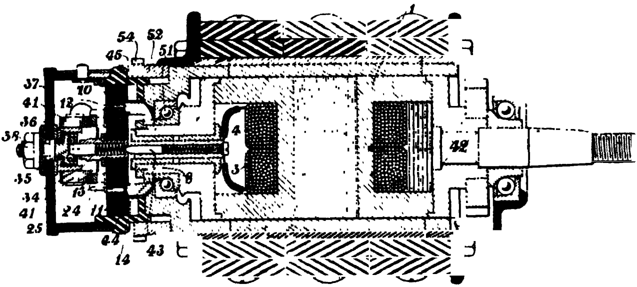

Fig. 44.—The Brooks Armature and L.T. Circuit.

3-4, double phase windings; 8, bossed end of armature cheek; 10, base of contact breaker; 12–13, driving pins with which the contact breaker engages 24, bearings in which cam piece rocks; 25, face cam of make and break; 37, metal cover over contact breaker; 38, terminal to switch (thence direct to primary end of coil); 41-41, fibre rollers having a rolling contact with the face cam; 42, condenser; 43, insulated plunger for condenser connection to contact breaker; 44, gun-metal ring with spigots 12-13 for driving contact breaker; 51, armature shaft ball bearing; 52 and 54, serrated collar for adjusting armature ball bearing.

The springs are held in place by bolts passing through the disc and holding a platinum pointed screw (32, Fig. 45) and the pivots of a keyhole-shaped lever (25, 26) on the face thereof. The two live ends of the armature winding are thus connected respectively with the platinum pointed screw and the keyhole lever, which latter also carries a platinum point (29) on its longer end.

These two points are mounted opposite two corresponding ones on a duplex blade spring (33) which is connected to the terminal (38, Fig. 44), on the cover, and thus to the terminal (21, Fig. 43), of the primary induction coil. These parts, except the terminal (38), all rotate, and they are brought into operation by a pair of fibre rollers (41) mounted on short radial axes in the stationary contact breaker cover. The keyhole lever is held up into contact with the rollers by a spring and is so shaped that, as it rotates, its longer end moves to and from the spring (33). In fact, it goes so far that it acts as follows :—As the armature moves from one minimum position the current begins to rise in both windings, but as the lever (25, 26) is pushed back by one of the rollers the point (39) on the spring (33) is separated from the point (32) and the current flows through the terminals (38, Fig. 44) and (21, Fig. 43) to the coil only from the winding connected to the lever (25, 26). When the armature reaches its maximum position, the lever is released, the contact is broken at the points (29, 40), and the points (32, 39) make contact, thus letting the reverse current generated in the winding attached to (32) rush through the primary of the coil in the opposite direction. Thus, twice in every revolution, before each maximum position of the armature is reached one of its windings is put in series with the primary winding of the coil through one pair of contact points, and the maximum position being reached this contact is broken and the other contact made almost instantaneously. The one

screw (32) serves for the adjustment of both pairs of platinum points.

The condenser is U-shaped, and is folded over the windings of the armature. One side is put in connection with the contact blade (33) by means of the insulated spring plunger (43) which bears against the end of the socket (34). This socket passes through the centre of the disc (10) and forms a bolt for the nut which holds the blade in place. The other side of the condenser is joined to the winding wire which is coupled up to the key-hole lever (25). The condenser thus bridges this part of the contact breaker direct; for the part (32, 39) it acts through both parts of the armature winding.

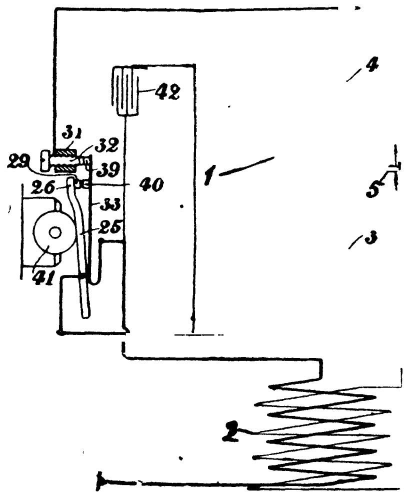

Fig. 45.—Diagram of Brooks Magneto Ignition.

Timing is effected by turning the contact breaker cover (37), which is provided with a reversible lever for the purpose; it has also an inspection aperture through which the action can

be observed while in operation. The cover is secured by a bayonet joint with spring catch, so that it can be instantly detached, and the distributer block is similarly fitted.

The contact blade (33) being the part that is common to both contact breakers, it is from this that the low tension current is conducted from the armature. It passes through the socket (34), and the spring contact (35) contained therein, to the terminal (38) through the small ball bearing shown.

While the contact breaker rotates with the armature, the coil turns at half speed with the distributer, the latter set being driven by the former through the gear wheels (7, 10). Both sets are mounted in ball bearings, and the same means are adopted to reduce friction in the case of the smaller rotating parts. The armature bearings are adjusted by the notched collar (52) which is held by a claw like a Bown bearing.

The coil (1) is of the ordinary induction construction with primary and secondary insulated windings and a soft iron faggoted core. The current generated in the magneto is fed to the primary winding of the coil by a cable connected to the terminals (38) and (21) on the one and the other respectively. The switch, simple or dual, as the case may be, should be introduced into this connection. From the terminal (21) the current passes through the ball bearing (19) to the spring contact (15) and the sliding metal socket in which it is mounted. This socket bears in a cup-ended insulated terminal (12) to

which one end of the primary is connected. The other end of the primary is earthed at (16), thus completing the whole primary circuit through the armature and coil. The part carrying the gear wheel (7) and brush (15) and lying between the terminals (12) and (21) is mounted in separate ball bearings (8, 8) and has a certain amount of independent movement longitudinally so that the parts may take their proper positions without binding. A spiral spring in the recess (6), holds the coil back on to the taper centre of the ball bearing at the other end.

One end of the secondary winding is also earthed ; the other end is coupled up to the spring contact (31) the head of which describes a circular path around the back of the distributer plate (26) into which are let a series of hard bronze contacts for the sparking plug wire terminals (32).

The alternate action of the contact breaker and armature windings is accompanied by reversals of direction of the current through the primary of the coil and this is arranged with the object of increasing the suddenness of the reaction in the magnetic field with corresponding intensity of the sparks.

A feature is made of employing hard steel contacts instead of the usual carbon brushes, and this allows of the introduction of ball bearings to reduce friction at these points.

CHAPTER VI.

The High Tension Magneto System.

WE now come to the section of electric ignition which comprises high tension magnetos properly so called; that is to say, magnetos that produce a high tension current without the assistance of an independent induction coil. This system was introduced subsequently to the low tension system, and the former was doubtless suggested by the latter. It naturally occurred to those who were studying the subject, that it would be a great gain if one could combine the advantages accruing from obtaining the electric energy from an automatic generator (instead of from a wasting battery) with the further convenience of a self-contained high tension sparking plug. And the most obvious way of attaining this result was to provide the armature with two windings after the manner of an ordinary induction coil, the core of the armature corresponding to the bundle of soft iron wire constituting the core of the coil, and the additional winding of the armature corresponding to the high tension winding of the coil. The problem was not so much one of theory as of practice. It is easy enough to wind an armature like a coil, but it is another matter to confine the dimensions of an armature so wound within practical limits,

especially as insulation must not be cut down unduly.

The first high tension magneto, at any rate from a commercial point of view, was the Simms-Bosch, but as this embodied certain peculiarities differentiating it from the general principle, it will be more convenient to consider one or two other machines first.

The Lacoste.

High tension magnetos do not differ greatly in general appearance from low tension magnetos,

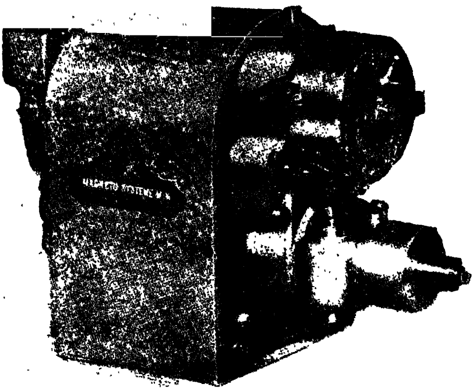

Fig. 46.—The Lacoste Magneto.

so far as the magnetos themselves are concerned, and this is true of the Lacoste. This magneto has six permanent magnets, A (Fig. 47), arranged

in three pairs, and bolted to soft iron pole pieces of the usual channel form. The pole pieces, in turn, are secured to an aluminium base. Two aluminium plates, the outer edges of which correspond in contour to the outer surfaces of the magnets, are fixed one at each end, while a thin metal band passing over the magnets and held down by screws combines with the base and end plates to form a box in which the magneto is encased. In this manner dirt and wet are excluded from the interior of the apparatus.

The armature D is of the usual H-section, but instead of being in a single piece has a laminated core. This core is wound first with a short primary winding of thick wire and then with a long secondary winding of fine wire, the windings being suitably insulated. One end of each winding is earthed to the armature, and the other end of the primary winding is led to an insulated metal ring, which will be observed as surrounding the armature near one end. The other end of the secondary winding is led through the other end of the armature spindle, which is made hollow for the purpose. This end of the high tension winding takes the form of a rod P, which is formed with a series of collars the better to secure the insulating material in which it is thickly embedded.

The ends of the armature are closed in by discs C, into one of which is screwed the driving part of the armature spindle, while the other disc has a hollow boss forming the other end of the armature spindle. The driving end of the spindle

is made in two parts arranged in line and abutting one against the other. In each part are two spiral or helical grooves, the one set of grooves

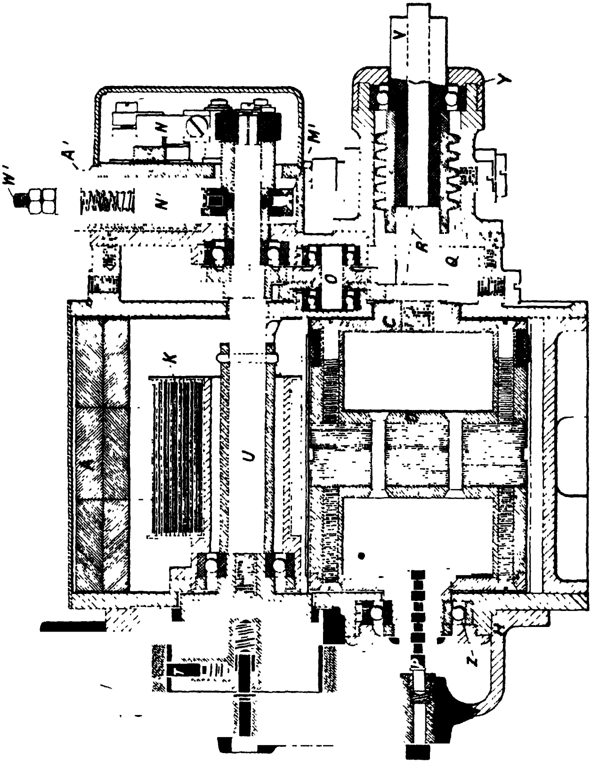

Fig. 47.—Longitudinal Vertical Section of the Lacoste Magneto.

being right hand and the other left hand. Surrounding the two parts of the shaft is a sleeve Q having pins which engage with the grooves and

external collars forming a kind of rack. Engaging in this rack is a toothed sector mounted on a spindle which also carries an arm or lever. Now it will be obvious that by rocking the sector, by means of connections applied to the arm, that the sleeve can be moved lengthwise on the parts of the shaft even while the sleeve and shaft are rotating, and the effect of so moving the sleeve is to cause the one part of the shaft to alter its angular position or, more simply, to rotate, relatively to the other. The one part is advanced and the other retarded according to the direction in which the sleeve is moved along. In this way the angular position of the armature may be regulated relatively to the gear wheel which is fixed to the outer part V of the shaft, and as the armature is driven at a definite speed relatively to the crank-shaft (as a matter of fact at the same speed as the crank-shaft in the case of a four-cylinder motor), the movement of the sleeve has the effect of advancing or retarding the time at which the armature reaches its maximum positions relatively to the moving parts in the engine, and as all the operations of the magneto are permanently timed through and relatively to the armature, all the functions of the magneto can be regulated together by the movement of the rack sleeve Q. It will be observed that both ends of the armature shaft are carried in ball bearings, the one close up to the disc and the other beyond the movable rack.

Above the armature and parallel to its shaft will be observed a second shaft U. This carries

at the right-hand end a low tension contact breaker, and at the left-hand end a high tension distributer. The shaft U is mounted in ball bearings, and is driven at half the speed of the armature by a train of wheels which will be observed at the contact breaker end of the apparatus. The intermediate pinion is carried on a spindle O mounted in ball bearings and is double. By constructing the pinion in this form the desired reduction in speed between the shafts is attained without the use of a large gear wheel, thus the spindle U can be set lower than would otherwise be possible and compactness is gained.

The primary current is taken off from the insulated ring of the armature by two brushes, one of carbon and the other of copper. These two brushes are mounted radially to the axis of the armature, one on either side of the spindle U, and are wired in series; that is to say, a single wire passes from the terminal of the one brush to that of the other, and thence to the insulated screw V of the contact breaker. The copper brush is employed principally to collect the current at the lower speeds, while the carbon brush is better for collecting at high speeds. The latter brush is not made of hard carbon, like most brushes, but is more of the nature of graphite, and so forms an excellent lubricator for the copper brush.

The contact breaker itself (Fig. 48) is of a fairly simple form. It comprises a cam M, with four projections on the end of the shaft U. Bearing against the periphery of the cam is a roller

carried by a bell crank lever. The roller is pressed into contact with the cam by a blade spring. On the other end of the lever is a metal tongue N, carrying one of the platinum points. This point makes contact with another carried by an adjustable screw V mounted in an insulated bracket. The wire from the brushes is connected up to the lower of the two terminals W, and between this terminal and the upper one similarly marked is introduced a switch. The primary circuit is, therefore, from the armature winding to the commutator or insulated ring; thence by the two brushes to the lower terminal W, through the switch, to the upper terminal W; thence through the insulated contact breaker screw and platinum points to the bell crank lever, and so to earth. The return is through the other end of the primary winding, which is also earthed. It will be observed that when the switch is open

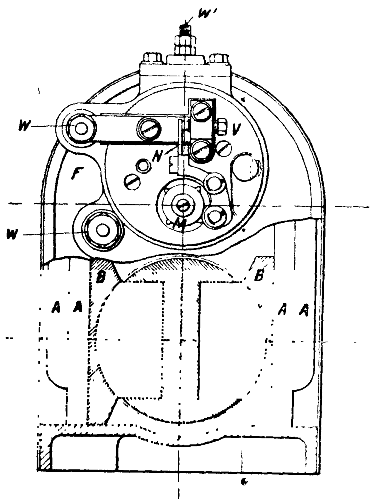

Fig. 48.—Elevation showing Contact Breaker.

no current will be generated, as the circuit will never be completed. But when the switch is closed the circuit is normally complete, and is only broken when the projection on the cam separates the platinum points of the contact breakers.

Turning now to the secondary circuit. We have already seen that one end of the high tension wire is earthed to the armature core, while the other (P) is led out through one end of the armature spindle. This end finishes off in an axial terminal, and against it bears a spring-pressed steel brush or plunger. From this a connecting rod Z (Fig. 49), embedded in the vulcanite cover I, transmits the current to a similar terminal in the insulation disc E, co-axial with the half-speed shaft U. Radiating from this last terminal is a carbon brush T, the outer end of which travels round a hard fibre track and distributes the current to the four equally distanced metal blocks L, let into the surface of the track. The brush is held up to its work by a light spring. These blocks L are in electrical connection with the terminals J, which are coupled up to the sparking plugs.

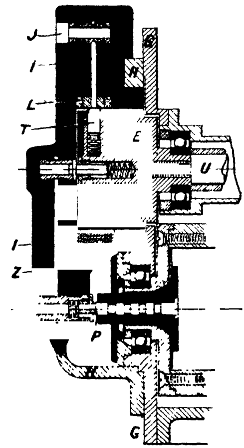

Fig. 49.—Vertical Section of Lacoste Distributer.

The contact breaker is timed so that the platinum tips are parted at the moments when the armature is in its maximum positions, and the advancing and retarding of the spark does not disturb this relation, as we have already seen. Normally, the primary circuit is closed, and as

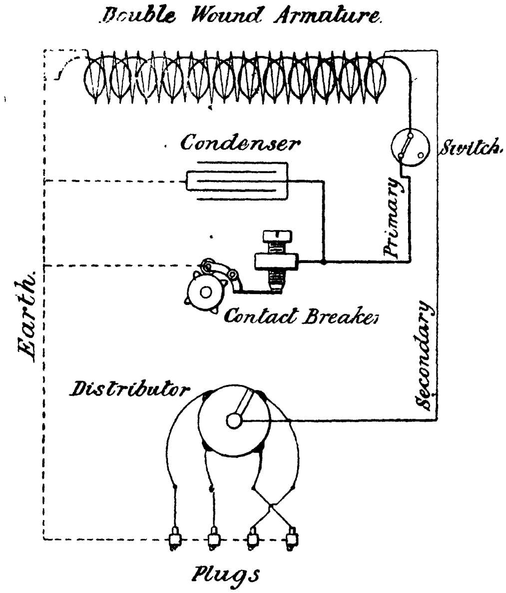

Fig. 50.—Diagram of the Lacoste Magneto System.

the armature revolves the current rises from zero to a maximum. Each time this maximum is reached, that is to say, twice per revolution of the armature, the points of the contact breaker part and the primary circuit is suddenly broken. This

induces a high tension current in the secondary winding, and this current is led to the proper sparking plug by the distributer.

But so far we have said nothing about the parts A^1, M^1, N^1, W^1 (Fig. 47). These are for employment when it is desired to carry an accumulator as a stand-by, and they form a wipe contact breaker. M^1 is a fibre disc having embedded therein four metal segments which are in electrical connection with the shaft U. The

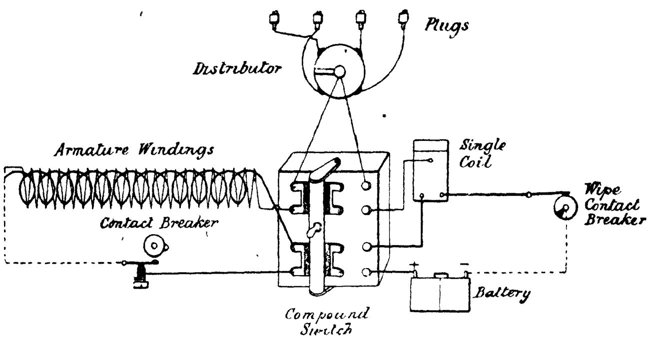

Fig. 51.—Diagram of the Lacoste Dual Ignition System with Compound Switch.

brush N^1 is pressed into contact with the surface of the disc by the spring A^1, the parts being mounted in an insulated tube and furnished with a terminal W^1. The battery is connected by its positive terminal to a single induction coil, and a compound switch is employed instead of the simple switch before referred to. When the switch is set over to accumulator ignition it completes the connection between the battery

and the primary winding of the coil. The same movement of the switch disconnects the high tension wiring of the armature from the distributer, and connects the high tension terminal of the coil to the distributer instead.

Hence by moving over the switch handle the magneto itself is cut out and the battery and coil are substituted therefor, also the wipe contact breaker replaces the make and break, but the distributer is employed in both cases, being transferred from the one system to the other.

The Simms and the Bosch.

In some respects the Simms or the Bosch high tension magneto should have been the first to be described in this class, as it is undoubtedly the pioneer and the best known; but, as its construction differs more or less from what may be considered the general principles of this type of magneto ignition, we have thought it best to delay dealing with it until the reader has had an opportunity of studying the high tension magneto system in a simpler form.

The Simms high tension cycle magneto is made in several different patterns, according to the different classes of engine to which it is adapted to be fitted; and, in order to make the construction as easily understood as may be, we shall first deal with the simplest types, namely, those supplied for single-cylinder motor cycles and cars, and subsequently will consider one or two types supplied for two and four cylinder engines.

The single-cylinder Simms magneto is constructed with an aluminium or gun-metal base (1), and gun-metal end plates (2), the latter carrying ball bearings (3) for the armature shaft (4). There are two simple magnets (5) placed edge to edge, and bolted to these are the usual concave

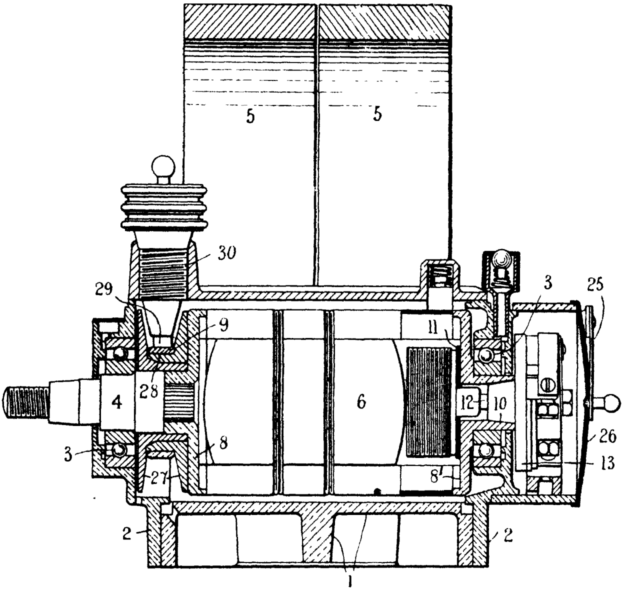

Fig. 52.—Longitudinal Section of the Simms High Tension Single-cylinder Magneto.

soft iron pole pieces. Screws pass up through the base into the pole pieces, and so connect them and the magnets into a single whole.

The armature (6) is of the usual H-section, with the ends of the cheeks projecting beyond the

body of the core. These projecting portions are of soft cast iron, but the whole of the middle part of the body is built up of soft charcoal iron laminations. The cast and laminated parts are secured together by three rivets, one running lengthways through each of the two cheeks, and the third through the centre of the coil.

On the core thus constructed is wound first a short length of primary wire, one end being earthed to the core. Around this primary winding is wound a long length of fine secondary wire. The layers of winding are insulated from each other by wrappings of silk or linen, and the primary and secondary coils are insulated from one another by similar means.

Now, one of the great differences between the Simms and the Bosch and many other magnetos comes in here. In these last, the primary and secondary windings are kept entirely apart from one another, except that they may both be earthed by one terminal. In the Simms, however, the inner end of the secondary winding is secured to one end of the primary winding, and that the live, not the earth, end. In fact the secondary winding is only earthed through the primary. From the point of junction between the primary and secondary windings a wire is led away to the contact breaker. The other end of the secondary winding is taken to a collector which is in connection with the sparking plug. Whether this method of arranging the primary and secondary windings be new or not, the result appears to be exceedingly satisfactory, and experiments have

shown that a weaker mixture of gas can be fired with a Simms or Bosch magneto than with an electric spark produced by ordinary apparatus.

The completion of the actual winding is followed, as usual, by a longitudinal binding of insulating tape and varnish to exclude damp, and a transverse binding of thread to prevent the main winding bulging, and so coming into contact with the pole pieces.

To each end of the armature is secured a brass disc (8, 8′) by means of screws passing through the discs into the cheeks of the armature. These discs carry the parts of the armature shaft in the ordinary way. One part of the shaft is provided with a taper portion to receive the driving spur or chain wheel, and with a screw-threaded part for the lock nut. Between

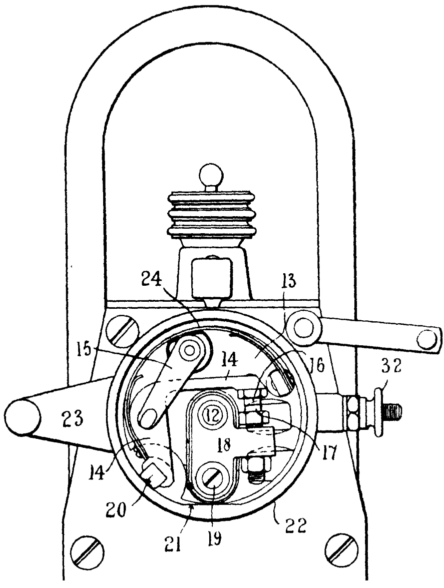

Fig. 53.—End View showing Contact Breaker.

this end of the armature and the bearing in the end plate is introduced the high tension collector (9) to be described presently. At the other end the armature shaft consists of a hollow boss (10) on the disc.

The wire leading from the junction between the two windings is attached by a small screw to an insulated brass piece (11) on the back of the end disc.

Passing down the centre of this end of the shaft is an insulated steel screw (12), which is threaded into the piece (11), and is therefore in electrical connection with it and the primary winding. The brass contact breaker plate (13) has a taper boss which enters and jams in the end (10) of the hollow armature shaft, with which the plate rotates. On the plate is mounted the bell crank lever (14). This lever is pivoted at its angle and is held in position by the small tongue (15). By pushing this tongue on one side the lever can be immediately detached from the machine, and the platinum contact (16) mounted in one end thereof can then be readily cleaned and adjusted. The other platinum contact (17) is carried by the bracket (18), which is in electrical connection with the screw (12), and is attached to the plate (13) (from which it is insulated) by the insulated screw (19) shown in the lower end of the bracket. All these parts of the contact breaker mechanism rotate with the armature, and all of them can be detached by simply withdrawing the screw (12). The contact breaker is actuated by a fibre block (20) let into the outer end of the lever (14),

engaging with a steel segment (21), mounted in a brass ring (22) which has a projecting arm (23) This ring is mounted on the frame of the magneto and can be rocked by moving the arm up or down. When the block on the lever (14) strikes against the segment (21), the platinum point on the other end of the lever is snatched out of contact with the corresponding point on the bracket (18). But when the block in its rotation passes off the segment, the contacts are closed by the curved blade spring (24), and they remain so until the block (20) again encounters the shoulder of the segment, when the points are again separated, and the primary circuit is broken as before.

There is a small carbon brush, carried by the plate (13) and pressing against the adjacent end plate of the machine, thus ensuring a good earth connection for the contact breaker lever (14). As there is only one segment it will be observed that only one of the two maximum currents per revolution is made use of, and the armature is driven at half the speed of the crank-shaft.

The condenser rotates with the armature, being located between its cheeks which are extended at one end to suit. As it rotates with the armature and contact breaker neither of the condenser connections need be of the rubbing kind. The primary winding is connected to the insulated brass piece (11) as before mentioned, but from this two connections branch off, one to the contact breaker and the other to the condenser. The other side of the condenser is earthed to the condenser casing and this is put

into electrical connection with the armature core and the earthed end of the primary winding

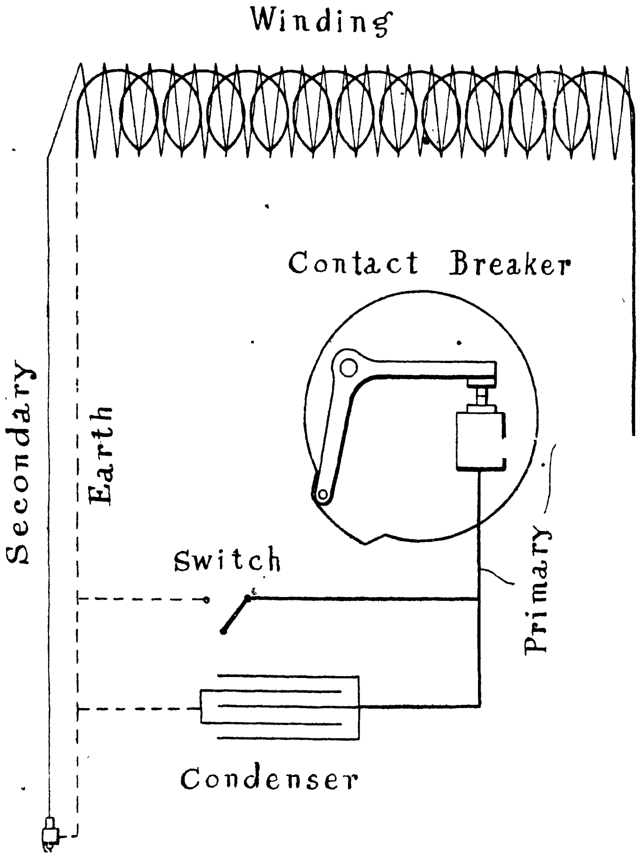

Fig. 54.—Diagram of the Simms and the Bosch High Tension Magneto System.

by means of the spring-actuated carbon brush which will be seen enclosed in a socket over the numeral 11 in Fig. 52.

When the platinum points make contact the primary circuit is completed. The current passes from the live end of the primary coil by the wire leading from the junction of the two windings to the brass piece (11). Thence by the screw (12) to the insulated bracket (18), through the platinum contacts to the lever (14), and so to the earthed end of the primary winding *viâ* the plate (13) and the armature shaft. When the primary circuit is broken the current is led to one side of the condenser by the branch of the primary, the connection of the other side of the condenser being to earth. The blade (25) holds the cap (26), the steel ring (21), and the brass ring (22), in position; and in order to detach these parts, it is only necessary to swing the blade away to one side or the other.

Turning now to the high tension circuit, it will be remembered that one end of the high tension winding is joined to the low tension. The other end of the high tension winding is led through an insulated hole in the disc (8) on the end of the armature, and through one side of the vulcanised fibre trough (27), into a small hole in the metal slip ring (28). Bearing on this ring is a carbon brush (29), which is held down by a spring contained in the ebonite holder (30). The high tension current induced by the breaking of the low tension circuit is thus led from the ring (28) through the brush (29) to the knob terminal on

the top of the holder (30). This terminal is adapted to receive a spring terminal on the end of the high tension wire which leads to the sparking plug. The high tension circuit is completed through earth, and through the primary winding, back to the junction with the secondary winding.

In order to save the insulation from the strain to which it would be subjected if the high tension current were induced while the high tension circuit was in an incomplete state, owing to the wire being detached from the plug or otherwise, a safety gap device is introduced. In this case it consists of a brass pin screwed into the cover plate and reaching to within a suitable distance of the slip ring. Hence, in the circumstances named, the high tension current can jump from the slip ring to the brass pin, and so to earth, without setting up too great a call upon the insulation.

The terminal (32) is for shorting the primary circuit by means of a switch when stopping the car or running on an alternative ignition. A blade spring is secured to the inside of the cap by a bolt, but is insulated from the cap. The free end of the blade bears on the head of the screw (12) and transmits the current to the terminal (32) to which one end of the switch wire is fastened. When the switch is open the magneto works as usual, but when it is closed the primary circuit is earthed continuously and no high tension current is induced.

The small single-cylinder Bosch magneto is similar, except that the boss on the back of the plate (13) has a parallel fitting and the switch

connection is somewhat different. The brass dust-cap (26) carries a bow spring, on the middle of which is mounted a carbon block. This block makes contact with the head of the screw (12), and conveys the current to the spring and thence to the insulated switch terminal (32)

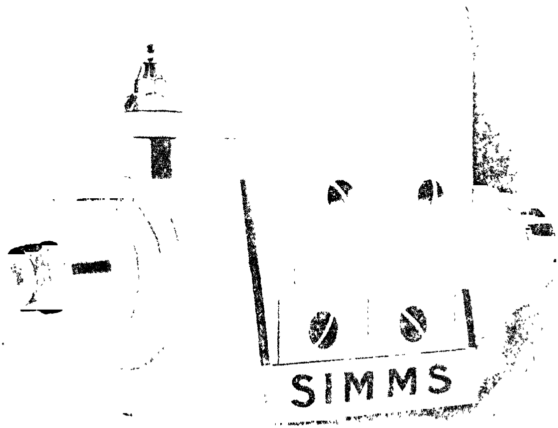

Fig. 55.—The Simms SI Single-cylinder H.T. Magneto (Car Type).

which is mounted centrally on the contact breaker cover.

The above description applies more particularly to the Simms magneto supplied for motor bicycles,

but the single-cylinder car magneto differs from it in comparatively few respects. The magnets are still two in number but are of larger size. One of the most important modifications consists in the construction of the contact breaker. This

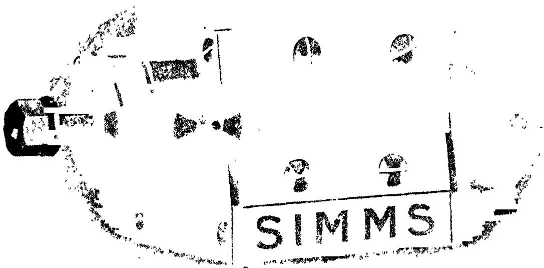

Fig. 56.—The Simms Two-cylinder H.T. Magneto.

is very similar to that already described so far as concerns the axial screw, the insulated bracket carrying one of the platinum contacts, and the bell crank lever carrying the other platinum contact. The other end of the bell crank lever,

however, instead of being adapted to work in conjunction with a segmental steel track, is so constructed that, in revolving, its outer end makes contact at regular intervals with two diametrically opposed hard fibre rollers mounted on steel spindles projected outwards from the timing plate. Thus, the contact is made and broken twice per revolution of the armature, and the wiping of the tail of the bell crank lever against the hard fibre rollers ensures a minimum of wear.

The spark gap is on more elaborate lines in the S.U., S. and S.D. types. The high tension collector carries a spring blade under the terminal. This blade projects under the arch of the magnets and bears upon the top of a porcelain cap, in the middle of which is a metal stud. The lower end of the stud is cut into four teeth, which oppose similar teeth formed on the upper end of a stud fixed in an aluminium plate which covers in the top of the armature. The space between the points is surrounded by a perforated drum lined with wire gauze. When the high tension current jumps across the safety gap the spark can be seen, while the gauze serves the same purpose as in a miner's lamp in preventing the flame passing out and igniting any combustible gas that may be hanging about. It also prevents any water or oil getting inside the drum and permanently shorting the high tension circuit.

Coming now to the Simms magnetos for two-cylinder engines, these are constructed generally on the lines already described for the single-cylinder

car engines, the differences being largely due to the speed at which the armature is rotated. As there are two makes and breaks per revolution of the armature, the number of revolutions of the armature relatively to the crank-shaft depends upon the position of the cranks relatively to one another. If the crank pins are co-axial or, as it is otherwise expressed, at 360 deg., one spark will be required at each revolution of the crank-shaft, and the armature will be rotated at half this speed, which is the speed of the cam-shaft. But when the cranks are diametrically opposite, although there will be one spark for each revolution of the crank-shaft, the sparks must occur at unequal intervals; that is to say, at intervals of one and three, instead of at intervals of two and two, as in the case of the co-axial crank pins. The simplest way to deal with this latter case is to run the armature at double the speed, which equals the speed of the crank-shaft, thus producing two sparks per revolution; so that the sparks will occur at the end of the exhaust stroke, as well as at the end of the compression stroke, in each cycle of each cylinder. It takes no more power to produce the four sparks than the two, and it avoids the necessity of using a distributer.

Whether the cranks are at 180 deg. or 360 deg., two carbon brushes with holders and terminals are employed, and are arranged diametrically opposite to one another. The slip ring has a metal block inserted, instead of having a continuous metal lead, and the high tension current is led to each carbon brush alternately. A very

simple form of spark gap is employed. A short length of wire projects from the high tension winding on the armature to within a suitable distance of the point of a screw mounted on one of the end discs.

The type of magneto constructed for two cylinder engines of the **V** type is particularly ingenious and interesting. The ordinary magneto, with its soft iron pole pieces and H section armature, is of course, adapted to give off a spark at equal intervals corresponding to the half rotations of the armature. But these intervals are quite unsuited to an engine having its cylinders, say, at 45 deg. The difficulty is very simply met by modifying the form of the pole pieces and the armature core. Taking the pole pieces first, each is of one form as to one half its length, and of another form as to the other half. Looking at one end of the machine it will be observed that the two pole pieces, instead of being of the same shape, are different in that the lips of one project considerably more than usual, while the lips of the other are correspondingly shortened. Thus a vertical plane drawn equi-distantly between the lips of the two pole pieces, instead of cutting through the axis of the armature, stands a considerable distance to one side thereof. So much for one end or half of the pole pieces. The other end or half is constructed in a similar way. But the pole piece that has its lips lengthened at one end has them shortened at the other, and *vice versâ;* so that a vertical plane taken midway between the lips of the pole pieces at this end will

lie as much to the right of the armature axis as the first plane lies to the left thereof.

The armature is also designed in halves, though this only applies to the core, not to the winding, which is like that previously described. The modification of the core consists in cutting away the sides of the cheeks, so that the two parts of the core, instead of being of H section throughout, are, approximately, T section at one end and ⊥ section at the other. A little consideration will show that the bridging of the pole pieces by the full parts of the cheeks of the armature and the other corresponding operations, instead of taking place at each 180 deg., will now take place at irregular intervals corresponding to the amount by which the vertical planes between the pole pieces deviate from the vertical plane through the armature shaft, according to the angle between the cylinders.

Fig. 57.—Pole Pieces and Armature of Simms H.T. Magneto for Twin-cylinder V Type Engines.

In this type the segment let into the slip ring

of the high tension collector extends to nearly a semicircle, and is sufficiently long to cover the angle between the cylinders and the advance and retard of the spark. There are two high tension collectors as before, coupled up to the respective sparking plugs by the usual high tension wires and terminals. One end of the armature and pole pieces serves one plug and the other end serves the other plug. The range of advance and retard is about 35 deg., corresponding to 70 deg. of the crank-shaft. A small spanner is supplied with the magneto ; it is provided with a spring attachment which allows it to be pressed on to the high tension terminal. When so connected one end of the spanner may be brought into proximity to one of the magnets, and if, on the armature being turned, a spark jumps across the gap between the spanner and magnet it will be known the machine itself is in order, and any trouble must be looked for elsewhere in the system.

The HDh Four-cylinder Bosch Magneto.

So far as we are aware, the first successful high tension magneto was the Bosch HDh. It is still a favourite with some, but it is now very largely superseded by the more recent simpler constructions.

There are six magnets arranged in three pairs, and these, together with the usual symmetrical soft iron pole pieces, are secured to an all-brass frame in the usual manner. It is when we come to the armature that we recognise the Simms and

Bosch practice, the arrangement employed in the case of the low tension magneto previously described being also in use here ; that is to say, the armature itself is fixed, while the cutting of the lines of force is effected by a soft iron, hollow cylinder or shield, which envelops the armature and rotates in the space between the surfaces thereof and of the pole pieces. Two opposite quarters of the cylinder are cut away, and the remaining portions are provided with end plates and with hollow stud axles fitting around the ends of the armature shaft. These hollow stud axles rotate between the ends of the armature shaft and bearings in the end plates of the magneto.

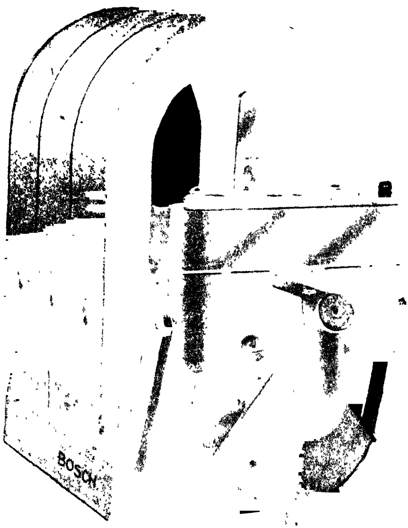

Fig. 58.—The Bosch Four-cylinder HDh High Tension Magneto.

The armature itself is laminated as to the middle part, as previously described ; and with the solid end portions of the cheeks makes up

the usual H form. The brass discs attached by screws to the ends of the armature are provided with spindles. One of these is integral with its disc and projects into the driving end of the sleeve stud axle. The other part of the armature spindle consists of a steel tube which projects

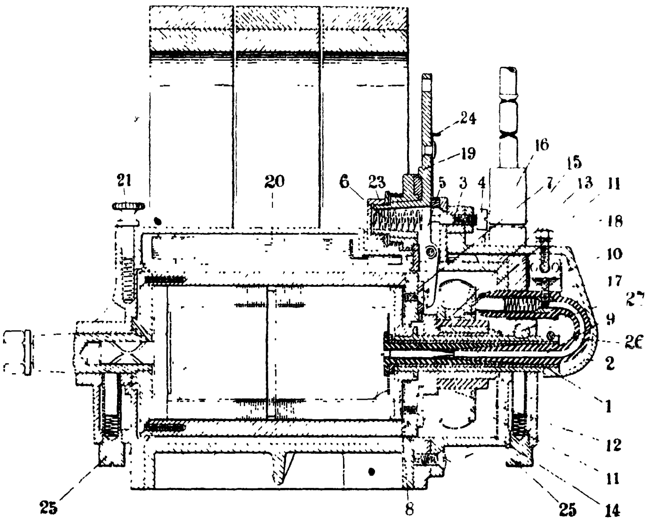

Fig. 59.—Longitudinal Section of the Bosch HDh High Tension Magneto.

through and beyond the corresponding part of the shield axle.

The winding is the same as in the other Bosch high tension magnetos. One end of the primary is earthed, and the live end forms a junction with one end of the secondary, while the

other end of the secondary is led to the high tension collector. From the point of junction between the two windings a connection is made to a brass tube (1), which passes through and is insulated from the hollow end of the armature spindle. To the outer end of this brass tube is clipped a conducting bar (2), which is bent to the peculiar form shown in the illustration. This metal bar curves upward and then runs back towards the machine, and finally carries a brass contact piece (3) in which is mounted the stationary but adjustable contact screw (4). The bar (2), the brass piece (3), and screw (4) are all insulated from the other metal parts of the machine. The other platinum contact is carried on the upper end of a pivoted lever (5), the lower end of which is pressed by the spring (6) into contact with the face of a vulcanised fibre disc (7), which is provided with four radial recesses. The disc (7) is secured to the end plate of the rotating shield. So long as the lower end of the lever (5) bears upon the face of the disc (7), the platinum point on the top of the lever is held out of contact with the platinum point on the screw (4). The distance between the two points at these times should be half a millimetre. As the shield rotates, the lower end of the lever periodically drops into the recesses brought opposite to it, and the platinum points make contact, thus completing the primary circuit, as the lever (5) itself is earthed. On the end or shoulder of a recess coming round under the lower end of the lever, the upper end is forced back

against the spring, the contact is broken, and the primary current is stopped.

The cessation of the primary current induces a high tension current in the secondary winding, and this occurs four times in each revolution of the shield, for, as we have already seen in connection with the low tension Simms and Bosch magnetos, the employment of the shield is attended by the doubling of the number of maximum primary current generations from two to four. Hence this magneto need only be run at half the speed of other high tension magnetos; that is to say, in order to produce the two sparks necessary per revolution of a four cylinder motor, the shield must be driven at the same rate as a half-speed or cam-shaft.

The timing of this pattern magneto is very ingeniously arranged. The lever (5) is pivoted in the lower end of another lever (19), and this lever (19) is itself pivoted on a longitudinal axis, coaxial with the platinum contacts. For this purpose, the lever (19) is formed with a hollow conical boss or pivot which fits into a correspondingly bored hole in the end plate of the frame of the machine, and the conical surfaces are held in close frictional contact by a short spiral spring interposed between the back of the end plate and a collar on the exterior of the conical boss. This conical boss is hollowed out to receive the spring (6) which actuates the lever (5). It will be obvious that by rocking the lever (19), the lower end of the lever (5) will be swung to one side or the other, and will be operated

by the recessed disc (7) sooner or later, as the case may be, and this without disturbing the relative positions of the platinum contacts. On the lever (19) is mounted a thin brass dust slide (24) which, when raised, uncovers the platinum points and allows their condition to be inspected.

The condenser is connected up across, or more properly in parallel with, the contact breaker. It is built up of interleaved mica and tin foil sheets as previously described, and is enclosed in an aluminium casing which forms a cover for the top of the armature. The connections to one end of the condenser are made by screws passing through the brass piece (3) on either side of the contact screw (4). The inner ends of these screws pass over the tops of bolts by which the cover of the condenser casing is fastened to its base. These bolts are also connected to one end of the condenser itself, and their heads carry small spring studs which project upwards into contact with the inner ends of the screws just mentioned. The other end of the condenser is earthed in the usual way. The brass piece (3) is in the form of a bar or bridge, and is insulated by a corresponding bridge of ebonite. The screws which form the connections between the brass piece (3) and the condenser bolts also serve to secure both the bridges to the end plate of the frame. Thus the leads to the condenser are the same as to the contact breaker as far as the brass piece (3), and then the former pass by the screws mentioned to the bolts in the one end of the condenser.

Turning now to the secondary winding, it will

be obvious that the live end of this cannot be carried through from the armature to a slip ring in the ordinary way, for two reasons; first because the armature is stationary, and second because the end plate of the rotating shield covers in the end of the armature and, so to speak, cuts it off from the outer world. The slip ring or distributer disc (12) itself is of the usual trough-like form, and is constructed for the main part of red fibre. Into its face is introduced a metal ring (11), and this face ring is in electrical connection with a brass insertion (13) in the bed of the trough. The connections between the secondary winding and the slip ring are effected as follows:—Within the brass tube (1) of the primary circuit is inserted a tube of insulating material which encloses a fine brass tube (8) secured to the live end of the secondary winding. The outer end of the insulating tube is bored taper to receive the correspondingly tapered end of an ebonite plug or rod, in which is embedded a piece of high tension wire (9). The wire projects from the plug and is split into two tongues, which make contact with the interior of the brass tube (8). The plug forms one end of a ⊃-shaped piece of insulating material shielding the length of high tension wire (9), which is carried around the bend of the ⊃ piece and connects the fine brass tube to a rod which is in contact with a spiral spring. The spring presses a carbon rod or brush (10) against the slip ring (11), and so completes the high tension connection between the armature winding and the slip ring. It will be seen that the high tension ⊃ piece is

covered and protected by the low tension conducting bar (2), and as these parts are in such close contact it is important that the insulation of

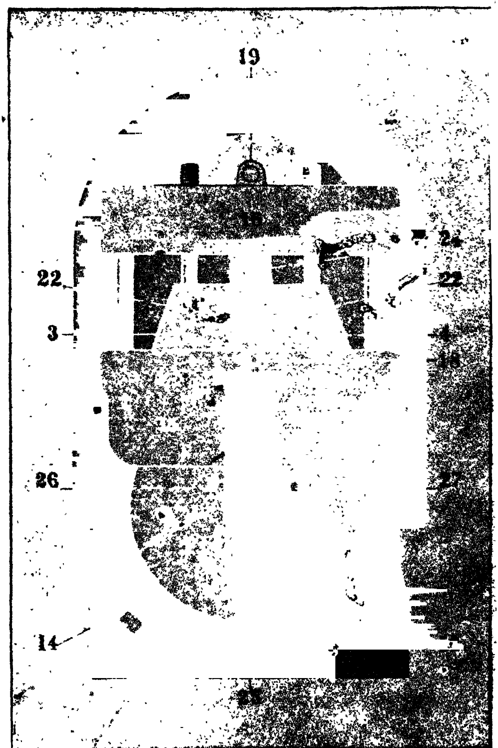

Fig. 60.—End View of the Bosch HDA High Tension Magneto.

the ⊃ piece should be very perfect, especially as it cannot be conveniently made of large dimension. The ⊃ piece is held in position by the clipped end of the conducting bar (2), which compresses the split end of the low tension brass tube (1) around the plug.

The slip ring (11) is connected electrically to the metal piece (13) inserted in the bed of the fibre trough (12) which is mounted upon the sleeve at the end of the shield. Four carbon brushes are arranged radially in ebonite holders and are pressed into contact with the bed of the trough by spiral springs. The outer ends of the holders are provided with metal terminals in contact with the springs, and these terminals are coupled up by metal strips to four brass terminals in the ebonite block (15). This block is made up of two pieces, a front and a back, which are subsequently cemented together. In the interior are four brass wires leading from the terminals mentioned to four vertical brass sockets, which are thus put into electrical connection with the carbon brush holders (14). A separate ebonite block (16) carries four plugs, the lower ends of which are adapted to enter the sockets in the block (15), while the upper ends form screw terminals for the attachment of the high tension wires leading to the respective sparking plugs. When the plugs on (16) are inserted in the sockets in (15) the connection between the brush holders (14) and the sparking plugs will be completed; while the connection may be severed at any moment by lifting up the block (16) with the

plugs attached thereto. The plugs and sockets are spaced unequally, so that the former can only be engaged with the latter the right way.

It will be noticed that the contact breaker and the high tension distributer are arranged at the same end of the machine and, both being attached to the shield, are operated at the same speed, which is half the speed of the crank-shaft. The parts are so arranged that the contact breaker opens at or about the moments when the shield is in its maximum positions and the metal inset or segment in the distributer is in contact with one of the carbon brushes, so that the sparking is obtained at the moments of maximum current.

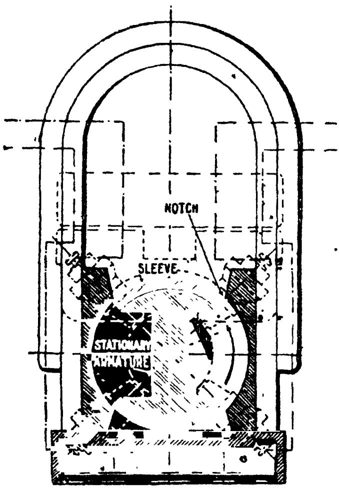

Fig. 61.—Section showing Armature of the Bosch HDh High Tension Magneto.

The movements of the timing lever (19) allow of the lower end of the contact breaker lever (5) being swung through an angle of about 30 deg. over the face of the recessed disc (7), and this corresponds to a range of timing of 60 deg. of the crank-shaft.

As the voltage of the current depends upon

the speed with which the shield is rotated, and as a weak spark is later in its effect than a strong spark, it is arranged that the best positions of the shield shall occur rather early in the cycle of operations of the engine; so the ignition should be advanced somewhat in starting up. The range of the timing lever (19) is limited by stops on the ebonite bridge interposed between the lever and the brass piece (3).

In connecting up the gearing for driving the magneto, the screw (21) should be removed and the condenser (20) withdrawn from its position above the armature. The sleeve can then be seen, and it should be rotated until a notch, which will be found upon the end of it, is brought opposite to the upper lip of the right-hand pole piece, looking at the machine from the driving gear end. This notch is nearly in line with the metal segment (13) in the trough (12) of the distributer, and when the parts are in the position mentioned, the metal segment will be in contact with the carbon high tension collector in the same angular position as the notch and segment. The piston in the cylinder with which this collector is to be connected (it may conveniently be the foremost one unless some other has been previously selected) should then be brought to the top of its compression (not exhaust) stroke. The timing lever (19) should be moved back, that is in the direction opposite to that indicated by the arrow marked on the driving end of the machine to show the way the shield is to be turned. Next rotate the sleeve in the direction of

the arrow until the platinum points are just about to break contact, and then the spur or chain wheel should be pushed on to the taper part of the shield spindle and firmly secured thereto by the nut and washer, taking care not to alter the position of any of the parts mentioned. The carbon holders should then be coupled up so that the plugs fire in the usual order, viz., 1, 2, 4, 3.

The switch is connected up by a wire fastened to the terminal (18) on the conducting bar (2). The other pole of the switch is connected to earth. So long as the switch is open, the magneto will operate in the usual way, but if it is desired to run the magneto without using the current generated thereby, as for example, when starting on accumulator ignition, the switch should be closed so as to earth the primary current and cut out the contact breaker. This will prevent the generation of a high tension current and no injury will result.

But to guard against accidental leaving open of the switch, and when one or more of the wires of the sparking plug are disconnected, a safety spark gap is introduced. This consists of a screw in connection with the high tension wire passing through the ⊐ piece (9), and another screw depending from the conductor bar (2). As a matter of convenience the same screw (18) is made to serve both for the switch terminal and part of the safety gap. The points of these two screws are arranged a certain distance apart, and a surrounding cage of perforated metal, with gauze lining, completes the device. When the

high tension current is prevented from taking its usual course through the sparking plugs, it can jump from the screw in the high tension circuit to the screw (18) in the conducting bar (2), and so travel back through the brass tube (1) to the junction at the other end of the secondary winding without passing through earth at all. It is necessary to set the two screws at about an eighth of an inch apart, as, if less, the high tension current would jump this gap each time in preference to jumping the gap between the electrodes of the sparking plugs in the compressed gases in the cylinders. As the strain on the insulation, when the safety gap is in operation, is considerable, the armature is liable to get hot and the insulation to be broken down. Hence, directly the safety spark gap is found to be in operation, steps should be taken, either by restoring the high tension connections to the plugs or by closing the switch to earth, as the case may be, to stop the sparking as soon as possible. The lower screw of the safety spark gap is surrounded by a soapstone sleeve to protect the ⊃ piece while the device is in operation.

Lubricators are provided at each end of the machine. The one at the front end has hinged lids, while that at the back or contact breaker end has swinging covers. On the upper part of the rear reservoir is a boss, through which a cotter pin (27) passes transversely. The cotter has a flat side, which bears upon a corresponding flat formed on the projecting end of the tubular part of the armature shaft, and so firmly prevents the

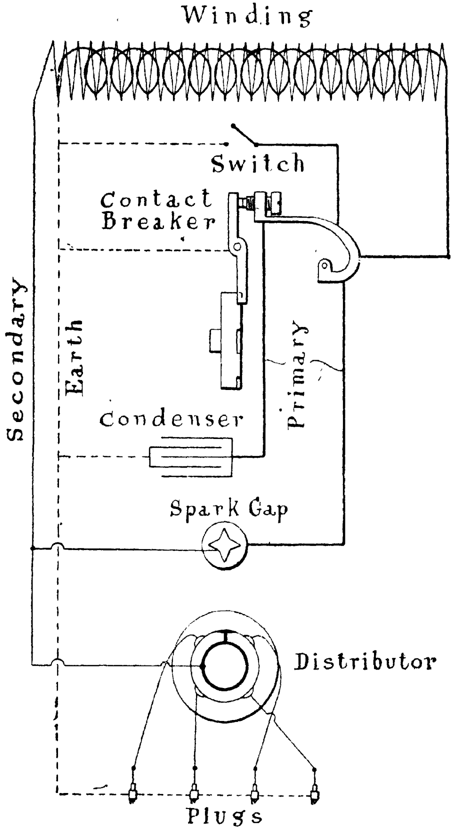

Fig. 62.—Diagram of the Bosch HDh High Tension Magneto System.

rotation of the armature. In the lubricators, felt wicks are carried in perforated screw holders, and are forced upwards by springs against the spindles of the shield. Holes are formed in these hollow spindles to allow of the oil passing through to the surfaces of the stationary armature shaft. At the contact breaker end, the armature shaft is made with a longitudinal groove on its under side for the reception of a horizontal wick, which conducts the oil along the rubbing surfaces of the armature and shield shafts.

The Simms S. and S.D. and Bosch D.R. and D. Four-cylinder Magnetos.

These popular patterns of the Simms and Bosch magnetos for four-cylinder engines contain many important differences from the HDh pattern, which was formerly the leading type and of which many are still in use. The frame is, of course, of a non-magnetic metal, in this case brass, both the base and the end plates being constructed of this material. The magnets are of the usual horseshoe form, six in number, arranged in three pairs. The concave pole pieces are bolted to the base by vertical screws, and the magnets are attached to the pole pieces by horizontal screws. Though the elements of the magnets are of the same number as in the HDh pattern, they are of somewhat smaller dimensions, and there is a corresponding saving in weight. The complications in the contact breaker connections and the high tension collector are avoided by

dispensing with the rotating shield and employing a rotating armature.

The armature core is of the laminated type described in connection with the single-cylinder patterns, and another similarity consists in forming the brass end disc at the back or contact

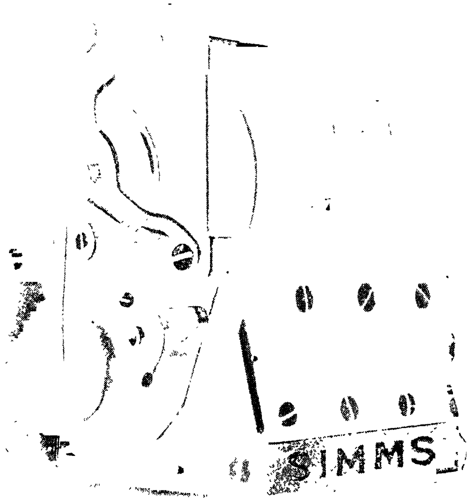

Fig. 63.—The Simms SD4 Pattern High Tension Magneto.

breaker end in the shape of a hollow cylinder or drum. This is for the purpose of providing accommodation for the condenser, which in this case is mounted at the end of the armature and rotates with it. The condenser connections are of course made in parallel with the contact

breaker, and for this purpose one end of the condenser is coupled up to the brass piece to which the junction wire of the winding is also connected. Hence when the contacts are broken the primary current is absorbed by the condenser, the other end of which is earthed through the condenser casing.

One part of the armature shaft is formed in one piece with the hollow end disc. The other part of the shaft consists of a steel tube having a square root which enters a corresponding socket on the end disc to which it is riveted. The two parts of the armature shaft rotate in single ball bearings. As the balls are mounted in retainers or cages which hold them together as a unit, and as the ball races are parallel, the balls with their retainers may be simply slid into position, and the outer races may be withdrawn without trouble when required.

The peculiar form of winding is the same here as in the other Simms and Bosch magnetos, the primary winding serving as an earth connection for the secondary winding. The low tension connections are the same as in the car type single-cylinder magneto. But in the contact breaker the outer end of the bell crank lever trails over two hard fibre rollers mounted on a plate which can be rocked through about 40 deg. for timing purposes.

The high tension gear is, of course, modified from the single-cylinder pattern as there are four plugs to be served. The live end of the high tension wire is taken direct to a metal slip ring

inserted in the bottom of a trough of insulating material. The trough is built up of two bevelled ebonite flanges each having a projecting boss, one larger than the other. The flange with the larger boss beds against the brass end disc of the armature, at the front or driving end of the machine. The boss of the other ebonite flange screws on to the boss of the brass disc, and

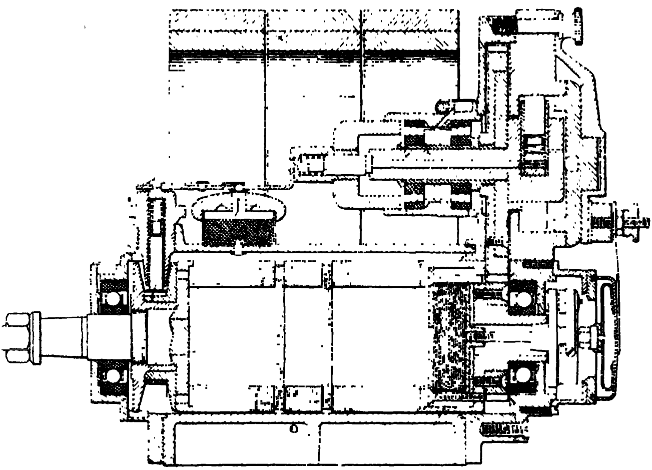

Fig. 64.—Longitudinal Section of the Simms and the Bosch Magnetos.

within the boss of the first ebonite flange, thus securing both in position. Bearing on the bed of the trough is a carbon brush carried in an ebonite holder which is screwed into a vertical socket on an aluminium plate. This rests upon the top of the pole pieces and covers in the top of the armature.

From the terminal on the top of the brush-holder a brass strip runs back under the magnets and is connected to one part of a safety gap, just as in the single-cylinder car model. But in this case the brass strip extends beyond the spark gap and is connected to a horizontal carbon brush carried in a tubular holder of insulating material. The further end of the brush makes contact with

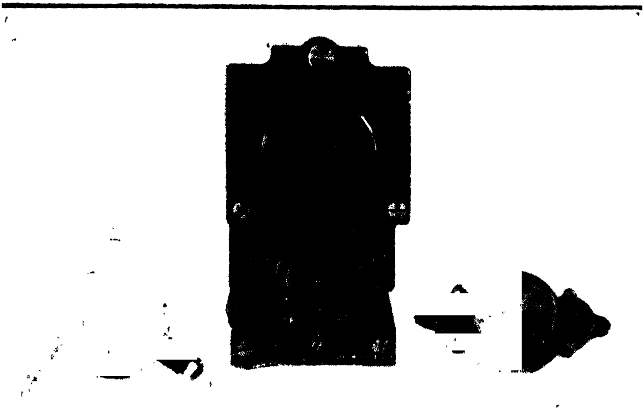

Fig. 65.—End View of the Simms and the Bosch Magnetos, showing Distributer and Contact Breaker exposed.

one end of a brass rod heavily coated with ebonite. To the contact breaker end of the armature is fixed a brass toothed wheel, which gears with a gun-metal and fibre wheel of twice its diameter. The latter wheel has a short hollow shaft, which is mounted in double ball bearings, carried by a projection on the end plate, extending a suitable

distance under the magnets. Not only is the shaft of the fibre wheel hollow, but there is a radial socket or recess formed in the body of the wheel. The heavily insulated brass rod above referred to fits into the hollow shaft of the gun-metal and fibre wheel, and an arm of insulating material on this rod fits snugly into the radial recess in the wheel, so that the rod and arm rotate with the wheel, but may be readily withdrawn therefrom. In the ebonite arm is a carbon brush of square section pushed outwards by means of a spiral spring, which makes contact both with the brass rod and the brush. The ebonite arm projects sufficiently beyond the face of the fibre wheel for the carbon brush to clear the wheel and make contact with four metal blocks inserted in a circular insulation track, similar to some already described in connection with other high tension distributers. These metal pieces are coupled up to vertical brass sockets embedded in the block in which the track is formed; and the open ends of these sockets are adapted to receive plug terminals on the ends of the respective high tension wires leading to the sparking plugs. The plug terminals are separate, instead of being embedded in a detachable block of ebonite as described in the HDh pattern.

Covering in the high tension distributer is an ebonite cover, in the centre of which is a steel contact which bears upon the back end of the insulated brass rod, and holds the same in position in case it should tend to work loose in the fibre wheel. The cover itself is held in

position by a three-arm bracket, the ends of which are slotted tangentially for engagement with headed pins projecting from the end plate

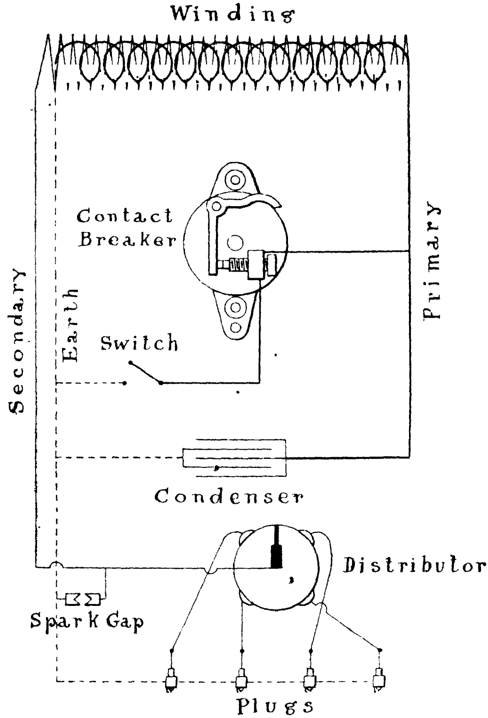

Fig. 66.—Diagram of the Simms and the Bosch Magnetos Ignition System.

of the machine. The ebonite cover is of circular form and fits into a circular recess in the distributer track. The three-arm bracket has a

central recess which fits over a corresponding projection on the cover, so that the parts are very quickly assembled and no difficulty is experienced in engaging the slotted ends of the arms with the studs. These studs are, in fact, screws; and after having fitted the bracket in position it is only necessary to tighten the top screw in order to make all secure.

Mounted on the three-arm bracket, but insulated therefrom by an ebonite plate, is a transverse bar of gun-metal. A spring blade is fixed to the centre of this bar by a screw. The blade projects downward and holds the brass cap in position over the contact breaker, as in the single-cylinder pattern magneto already described.

A connection is made between the axial screw holding the parts of the contact breaker in position and the screw holding the blade, by a carbon brush carried by a spring in the cap, and the blade. The cap itself is insulated by setting it on a fibre ring let into the timing plate. These connections are, in this case, required only for the switch, the condenser being coupled up differently, as we have seen. The wire running to the switch is connected to the screw holding the blade. By moving the blade to one side the contact breaker is exposed as before; or, by releasing the three-arm bracket, the ebonite cover and brass cap come away, and both the distributer and contact breaker are immediately laid bare.

As ball bearings are provided, comparatively little lubrication is required, but oil reservoirs are

provided for all three bearings. The third, of course, is that of the distributer; it is situated between the end plate and the magneto at the rear end of the machine. An arrow calls attention to this lubricator, with "oil" in three languages.

The Simms S.D. and Bosch D. magnetos are constructed on similar lines.

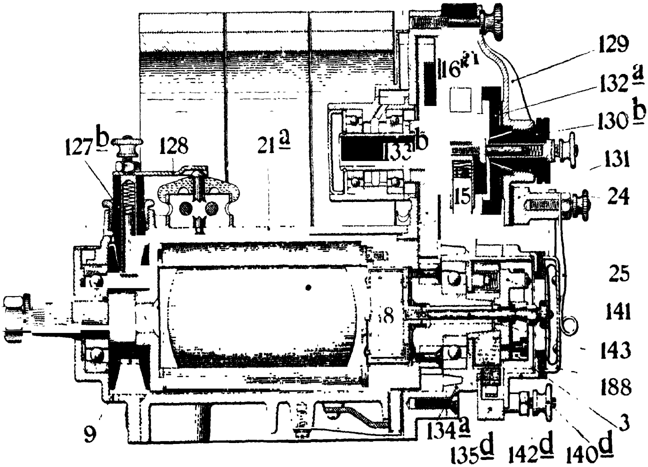

Fig. 67.—Longitudinal Section of the Bosch Dual Magneto.

In the Bosch Dual Ignition system the same plugs, cables and distributer serve for both the magneto and the coil. There are two contact breakers, but they are both mounted on the armature shaft. The magneto contact breaker is the standard one illustrated in Fig. 65; the

one for the coil ignition consists of a lever (136^{c}) carrying a platinum point on one end and a fibre block on the other. A blade spring (137^{b}) presses the fibre block on to a cam having two projections which cause the platinum point on the lever to part from the other platinum point twice per revolution of the armature. The second platinum point is on the tip of a screw which is mounted on and insulated from the casing. The outer end of the screw forms a terminal for the wire running to the battery through the switch. This contact breaker is located behind the other and is provided with separate timing arms (135^{d}). The two contact breakers open simultaneously.

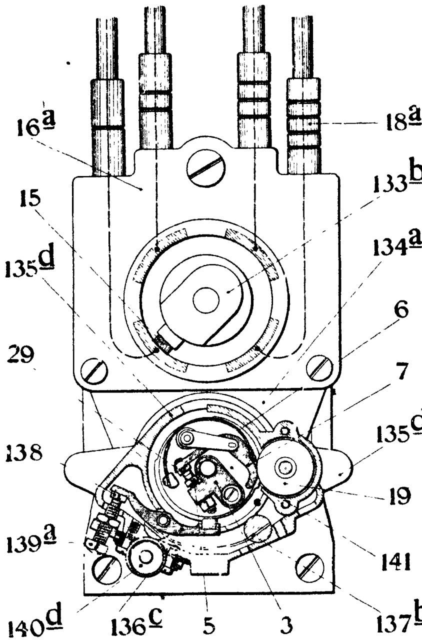

Fig. 68.—End View of the Bosch Dual Magneto.

The high tension current instead of being led

direct from the collector brush (127^b) to the distributer is now taken first to the switch by a cable and then from the switch to the terminal (130^b) on the distributer. Of course, the switch provides for the alternative of cutting out the magneto connection and linking up the high tension terminal of the induction coil thereto instead. The carbon brush in the terminal (130^b) bears on a metal plate let into the centre of the face of the distributer arm (133^b).

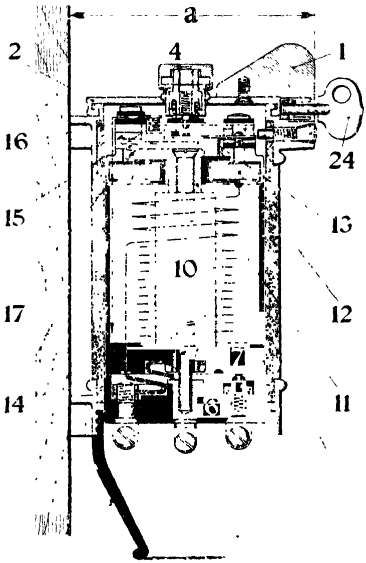

Fig. 69.—Bosch Dual Magneto, Section of Coil.

The coil and the switch are housed in a single cylindrical case (3) (Fig. 69), the one above the other. The coil is constructed with a cylindrical armature (10), and the primary and secondary windings are separate. The condenser (12) is placed on top of the coil, and over this again is the trembler (13, 14). But this trembler is only operated by a spring button (4) for starting; at other times the coil acts as a plain transformer. The coil terminals are formed as flush contacts in

the base, and bear a spring plunger terminal in the switch block (7). The switch handle (1) is fixed to the case itself, and serves as a simple device for setting the switch at M (magneto), O (off), or A (accumulator), as the case may be. Depressing the button (4), on re-starting, pushes down the blade (15), breaking the contact with one of the points (16) and making it again with the other. This produces a single spark which can be repeated by further operation of the button, and should result in the starting of the engine, if the cylinder contains a charge of gas. The detachable key (24) is for locking the switch in the "off" position, and so preventing unauthorised use of the car.

The connecting up is considerably facilitated by using coloured cables.

These magnetos are supplied either with fixed or with variable timing, and either with one or two pairs of magnets; two pairs are recommended if the timing is to be variable.

The Nieuport.

The Nieuport magneto is perhaps not so well known on the English market as some other makes, but it possesses features which are certainly worth considering. To begin with, the frame, instead of being built up on a base with separate end plates, and possibly a cover plate over the pole pieces and an extension carrying the distribution gear, has all these parts cast *en bloc* in Cothias metal, except only one of the end plates,

which is necessarily detachable in order to allow of the armature being put in position. The pole pieces almost constitute parts of this casting, for they are shrunk into the frame and held by it without bolts or other fastenings. The initial difficulties of the casting being overcome, the result is an exceedingly simple structure of con-

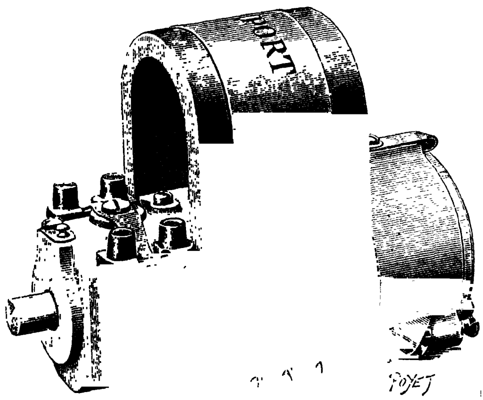

Fig. 70.—Nieuport 4-Cylinder Magneto.

siderable strength, and very effective in excluding dust and wet.

The Nieuports were in the van in pointing out that a large engine did not necessarily require a cumbersome magneto. The magnets are of moderate dimensions individually. They are secured in place partly by the inner members

resting on shoulders formed on the frame, and partly by brass strips bound down tightly by screws passing therethrough into the base. The magnets themselves are not penetrated by any holes.

The armature is of the usual H type, with laminated centre (9) and cast extremities. The ends are bridged across by the usual discs (19, 20), to the latter of which the driving spindle (5) is secured by a special coned joint. The disc (19) has a hollow boss, and the spindle and boss support the armature in ball bearings carried by the plates (10) and (14).

The most remarkable feature of the Nieuport magnetos, at any rate those designed for two- and four-cylinder engines, is that no distributer gearing is used. We shall deal with this directly, but it is referred to here because it affects the armature windings. The inner end of the primary wire is earthed to the core, and the outer end is connected to the platinum-tipped screw of the contact breaker by an insulated central bolt (18). This is well-known practice; the novelty comes in in connection with the high tension winding. Not only is one end of this connected to a slip ring, but the other end (instead of being directly earthed or connected to the primary winding) is also connected to a slip ring, so that neither is earthed.

The condenser (17) is of annular form, and fits over the boss on the end disc (19), keys preventing relative rotation of the parts. The case of the condenser forms the plate on which

the rotating parts of the contact breaker are mounted. The keys ensure the condenser being fitted in the proper angular position for the correct timing of the contact breaker. An insulated plate is mounted on the inner face of the disc at this end of the armature, and to it is secured the junction end of the primary

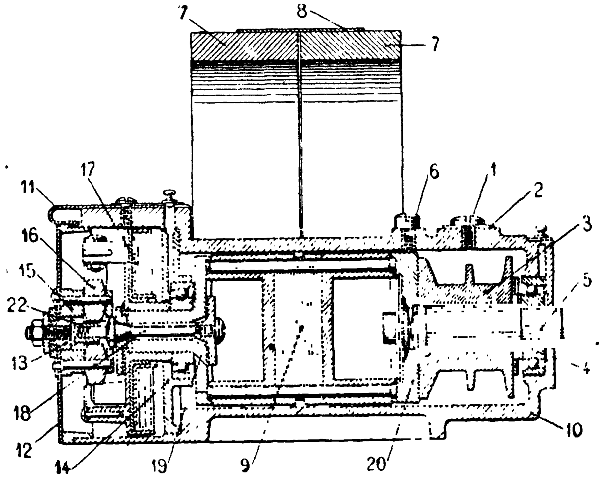

Fig. 71.—Longitudinal Section of the Nieuport Magneto.

winding. The plate has a boss projecting within the hollow spindle of the disc, and the boss is bored to receive the bolt (18), which projects right through the condenser. The bolt carries a nut by which the condenser is secured in place, and it also holds an insulated radial metal strip on the outer face of the condenser case. To

a bracket projecting from the end of this strip is fixed one of the platinum points of the contact breaker. Hence, this platinum point, though insulated from other parts, is in electrical connection with the primary winding, the other end of which, as already intimated, is earthed to the body of the armature.

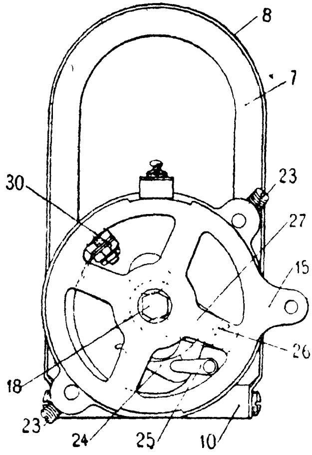

Fig. 72.—End View showing Contact Breaker.

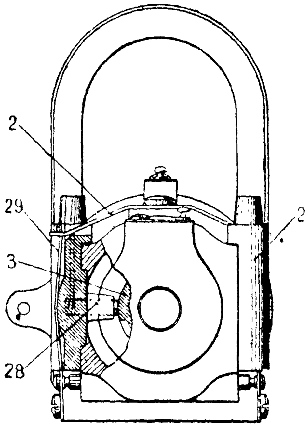

Fig. 73.—End View showing Distributer.

A bell crank lever (24) is mounted on the outer face of the condenser and carries the other platinum point on one of its arms. The lever is held on to its pivot by a small spring (25), which can be readily turned aside to release the lever when it is desired to examine and attend to the platinum points. So long as the platinum points

are in contact the primary circuit is complete, and they are retained in this position by a curved band spring, but when they are parted this circuit is broken and a high tension current is induced in the secondary winding. The separation of the points is effected by two rollers (16) arranged diametrically opposite one another in the path of the other end of the lever. The rollers are mounted upon two horizontal pins carried by a wheel-like frame (15) set concentrically with the armature and the bolt projecting therefrom. As the rollers are so arranged as to operate upon the inner surface of the lever (24), the construction is very compact. The rollers cause the breaking of contact to take place twice in each revolution of the armature at or near the two maximum positions thereof. The wheel frame is provided with an ear or lug by which it can be moved through a suitable angle, so as to cause the separation of the contact points to take place earlier or later and the spark to be thereby advanced or retarded.

In the centre of the cover plate is an insulated terminal (22), the inner end of which has a spring pressure contact with the outer end of the axial bolt. This terminal is connected up to earth through a suitable switch, which serves the usual purpose of earthing the primary current when the magneto is being run idly, that is without producing sparks.

Returning now to the secondary circuit, four carbon brushes (28), arranged in two horizontal pairs, are mounted in the distributer block (21),

and bear upon the two parts of the double slip ring (3). The brushes are in electrical connection with four vertical sockets (21), which are adapted to be coupled up to the respective sparking plugs in the usual way. The carbon brush-holders and the contact breaker cover (12) are held in place by readily displaced spring catches. The metal seg-

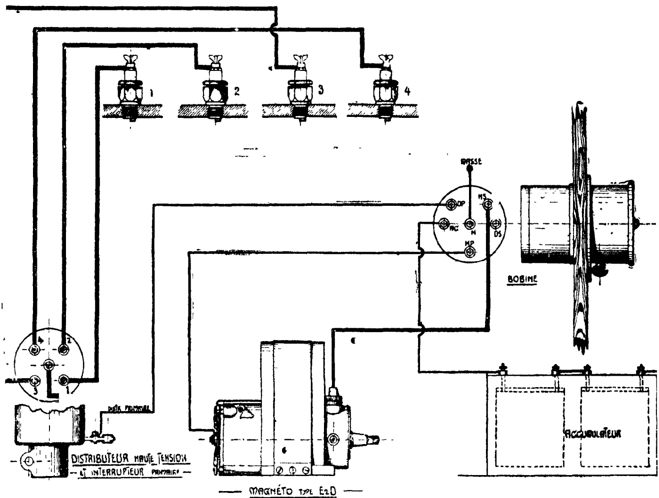

Fig. 74.—Wiring Diagram of Nieuport Dual Ignition System.

ment in one slip ring is arranged diametrically or rather *diagonally* opposite that in the other. The carbon brushes bearing on one slip ring are coupled up to the cylinders the two pistons of which move oppositely, say, to the first and third cylinders; and the brushes of the other ring are

coupled up to the second and fourth cylinders. The combined effect of these two arrangements is that sparks occur in cylinders (1) and (4) simultaneously and in cylinders (2) and (3) simultaneously. If the pistons in cylinders (1) and (3) move together, instead of oppositely, the connections would be rearranged to suit.

The current passes from one end of the secondary winding by the slip ring, brush, and cable, to one sparking plug, and back from the other sparking plug by corresponding means to the other end of the secondary winding. The metal of the engine completes the circuit, which has two gaps in it, one at each sparking plug, at both of which sparks will occur simultaneously. The armature being driven at crank-shaft speed, one spark will be usefully employed in firing the compressed charge in its cylinder, while the other spark will be harmless though unnecessary, as its cylinder will be exhausting spent gases; in fact, it may be useful, both directly in itself and indirectly in its gap, in keeping the plug points or "electrodes" clean.

Two nickel points forming a safety spark gap are mounted on the high tension winding of the armature and the disc (20). In the edge of this disc is a notch, and, when it is desired to set the timing of the magneto, the screw (6) is removed and a wire thrust down the hole and the armature is turned until the wire enters the hole. When the armature has been turned, as far as the wire will allow it, in the direction it is intended to run, the driving coupling or gear wheel may be fixed.

The armature is now in a position corresponding to the maximum advance, so that the piston should have risen somewhat short, say, 3 to 7 mm., of the top of its compression stroke, and the fellow piston to within the same distance of the top of the exhaust stroke. The plugs for these two cylinders are coupled up to the carbon brushes in contact with the metal insets in the slip ring indicated by red spots on the brush holders (21).

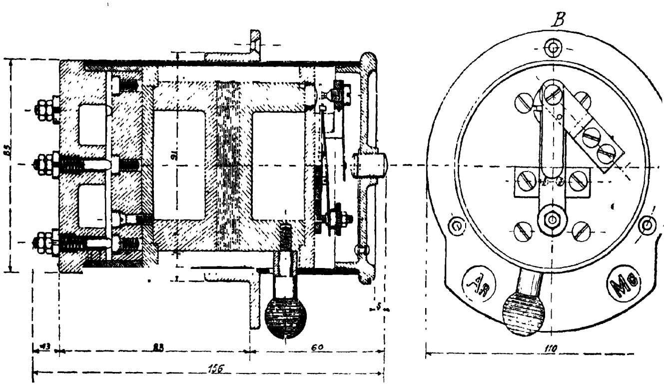

Fig. 75.—Section and End View of Nieuport Dual Coil and Switch.

The other two plugs are similarly connected to the remaining two brushes. So long as the connections are made to the proper pairs, the precise order does not matter. It is certainly an ingeniously simple idea.

The Nieuport Dual Ignition System is designed to allow of running on either the magneto or the battery current and to provide for starting on the switch.

The magneto employed is principally on the lines described above, but it has an external safety spark gap and a single high tension terminal which is coupled up in a switch to a high tension distributer and low tension contact breaker which are driven together at half crank-shaft speed. The distributer serves for both the magneto and the coil, but the contact breaker is for the coil system only, as the magneto has its own. The terminals on the distributer are connected to a single set of sparking plugs.

The high tension current received at the centre terminal of the distributer is fed by a vertical brush to a radial metal arm, the outer end of which is in connection with a second vertical brush which distributes the current to metal insets under the sparking plug terminals. The low tension wipe contact breaker is on similar lines. The switch is combined with the trembler coil and is mounted on the dashboard. The coil is constructed like a magneto armature with H core and has a condenser wrapped round it. It has surface terminals bearing against spring plungers in the switch, and the coil is rotated in the casing to effect the various switchings on and off in changing from coil to magneto and *vice versâ* and switching off altogether. To restart the engine the switch handle should be placed over Ac. (Accumulator), and if this does not produce the desired result, a spring button in the centre of the switch case should be pressed once or twice. This makes and breaks the primary battery circuit, and so excites the coil and trembler and produces the necessary spark.

The Mea Magneto.

The Mea Magneto differs in appearance from others in that the magnets lie parallel, instead of perpendicularly, to the armature. There are two magnets of approximately helmet or bell shape, one arranged inside the other and both fitted with pole shoes at their free ends. The

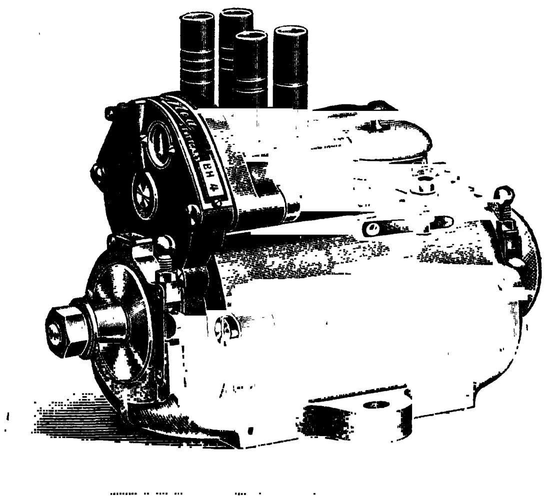

Fig. 76.—Mea Magneto, Type BH 4.

limbs of the magnets and the pole shoes are all co-axial with the armature, the shaft of which passes through the crown of the magnets. The magnets are in effect pivoted on the armature, and advantage is taken of this to accomplish the advancing and retarding of the spark by rocking

the magnets. This maintains the breaking at the maximum position, as with adjustable armatures, with the simplicity of driving and control of the movable contact breaker magnetos. The range of advance and retard is very great, and it is not necessary to advance the spark at starting.

The primary and secondary coils are wound continuously on the H solid iron armature.

The condenser is mounted on the armature next to the windings, and beyond it is the slip ring from which the high tension current is picked off by a carbon brush. The inner end of the primary winding is earthed, and a carbon brush bearing on the condenser casing makes an easier return for the primary current from the fixed platinum point, than if it had to pass through the lubricated ball bearings in which the armature spindles rotate.

The junction of the windings is coupled up to the axial bolt of the contact breaker. The Mea contact breaker is somewhat like the Nilmelior. The platinum pointed screws lie parallel to the armature shaft. The fixed screw is mounted on the metal contact breaker base plate, while the adjustable screw is carried by an insulated horseshoe spring. A stationary ring in the back of the contact breaker has two diametrically opposite radial projections, and as the contact breaker rotates, a roller mounted on the base plate encounters these projections at each half revolution and, acting on the spring, breaks the contact between the platinum points. A carbon block carried by a blade spring bears on the head of the bolt and

leads the primary current in the spring to a switch terminal on the top of the contact breaker cover. The timing lever projects from the con-

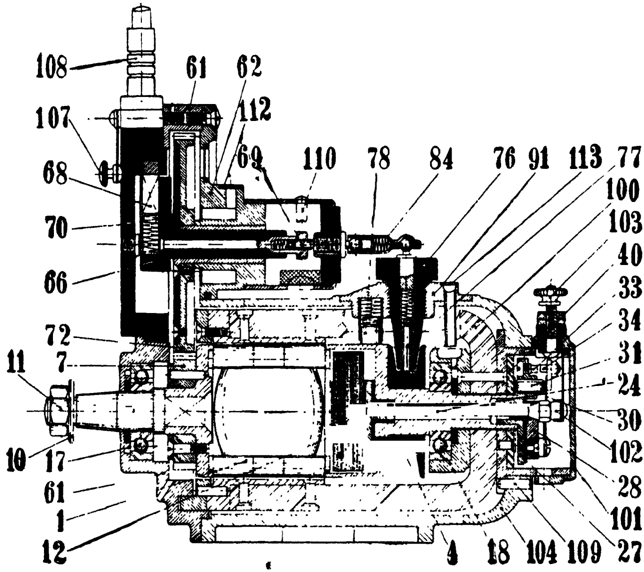

Fig. 77.—Longitudinal Section of the Mea Magneto.

1, armature; 4, slip ring; 7 and 72, distributer gear wheels; 12, condenser: 17, 18, ball bearings; 24, central screw; 27, contact breaker disc; 28, insulated contact; 30, contact breaker spring, 31, roller; 33, 34, platinum screws; 40, ring with radial projections; 62, window; 66, distributer arm; 68, carbon brush, 69, high tension connection; 70, distributer plate; 76, high tension collector, 77, carbon brush; 78, return circuit contact: 84, detachable bridge; 91, slip ring cover; 100, magnet; 101, contact breaker cover; 102, 103, spring and carbon, and terminal for switch; 104, main casing; 105, screw for retaining contact breaker case; 106, timing lever; 107, pin for retaining cover; 108, sparking plug wire spigots; 110, spark gap; 112, 113, lubricators.

tact breaker case, but as the latter is fixed to the magnets the results are as above stated.

The magneto is enclosed in a casing through which the contact breaker projects at the crown end. The distributing gear is at the driving end of the shaft. The high tension current is conducted through the distributer spindle to a radial brush making contact with metal fillets in an internal track. One section of the connections is readily detachable, and the next one is provided with a lantern spark gap. The distributer cover is also readily detachable and is furnished with a window through which numbers or lines marked on the larger gear wheel can be seen. These marks indicate the cylinders in which firing is just about to take place, and corresponding numbers of collars turned on the spigots of the sparking plug leads make the task of wiring up an engine a simple one.

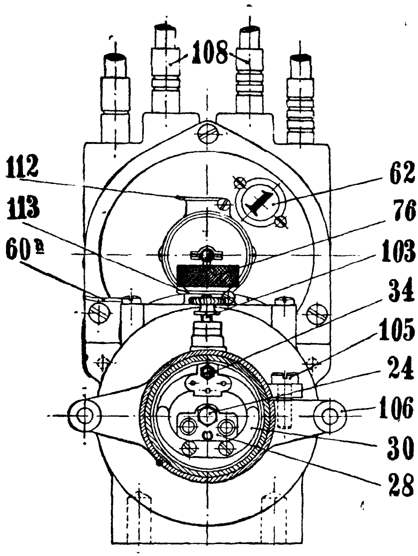

Fig. 78.—The Mea Contact Breaker.

In another model, the whole magneto, casing and all, is mounted in a trunnion bracket and is turned therein for timing purposes. In this pattern the switch terminal is on the end of the contact breaker cover, and point and slip ring spark gaps are used. As arranged for a four-cylinder motor, there are two radial distributer brushes at right angles, in different planes from one another, making contact at intervals with two corresponding sets of fillets. In this case the timing range is about 70°.

The Eisemann High Tension Magneto.

The Eisemann was one of the earliest magnetos on the market and, as originally constructed, had a single low tension winding, the high tension current being induced in a separate coil. A full description of it appears in the first edition of this book.

The present standard Eisemann is a self-contained high tension machine and possesses several notable features. There are two single magnets placed edge to edge and they are marked in such a way that if they are separated they can easily be replaced in their proper relative positions.

The edges of the pole pieces are inclined, one tapering towards one end and the other towards the other, so that while the gap between them is parallel-sided it lies obliquely to the axis of the armature. This slightly graduates the cutting of the lines of force and reduces the strain on the insulation.

The armature has a laminated body and rotates in ball bearings; it is double wound, and the outer end of the primary wire is coupled to the fixed point of the contact breaker by an axial bolt. The moving platinum point is on one end of a bell-crank lever, the other end of which is shod with a fibre pad which trails against two cylindrical bolts. Each encounter of the pad with a bolt causes the separation of the

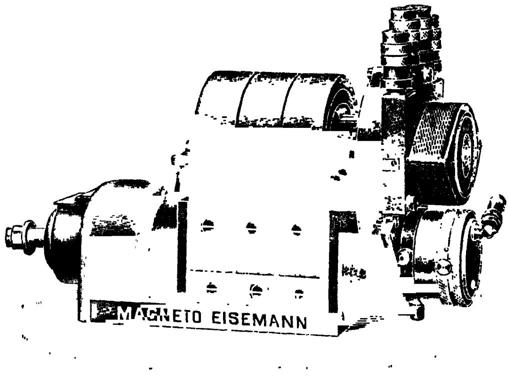

Fig. 79.—The Eisemann Magneto.

platinum points, and the bolts are rotatable so that new surfaces can be brought into use in case of wear.

The annular condenser is arranged at the contact breaker end of the armature and rotates therewith. A carbon block carried on a blade spring inside the contact-breaker cover bears on the head of the axial conducting bolt and

conveys the current to a switch terminal on the outside of the cover.

The contact breaker is not movable relatively to the armature for timing purposes, but instead of this, the present machine includes another old Eisemann feature, which consisted in effecting the variation of the timing between the motor and the armature so that the armature was always at its maximum position when the contact breaker opened. This has been retained in the latest model, and developed into an automatic timing device. It is constructed as follows.

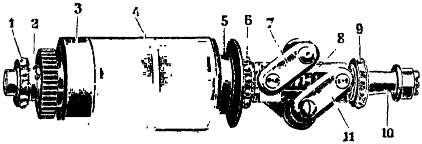

Fig. 80.—Eisemann Automatic Timing.

1, 6, 9, three ball bearings; 3, condenser case; 4, armature core and windings, 5, high tension collector ring; 7, 11, regulator weights; 8, regulator spring, 10, driving axle.

The spindle carrying the driving gear wheel is not fixed directly to the armature, but is connected thereto by a coupling which allows of relative angular movement during running. The spindle has two spiral keys projecting from its surface, and these engage in corresponding keyways cut inside a square block, through which the spindle passes. The block can slide lengthwise, but not rotate, in a double guide projecting from the end of the armature. The arms of a centrifugal governor are pivoted to the guide and to the block respectively. Hence, as the

revolutions of the armature increase, the weights of the governor fly out further against the action of the spring, and draw the block along the guide towards the armature, and so "advance" the armature relatively to the gear spindle. By these means the break occurs, and the spark is produced at the best positions relatively both to the current generation and to the cycle of operations in the motor. This at least is the theory of the matter, and the approximation in practice is no doubt fairly close. The range of timing is about 60°.

The fixing of the gear wheel in the right position on the spindle is greatly facilitated by the provision of a special key which locks the armature and spindle at the position they should occupy when the piston is at the firing point.

The live end of the high tension winding is coupled to a slip ring at the driving gear end of the machine. A carbon brush collector transmits the current to the rotating arm of the distributer through suitable connections with a "lighthouse" spark gap. The distributer arm carries a horizontal steel brush making contact with metal fillets in the face of the distributer plate, and the connections to the plugs are as usual.

The contact breaker is secured in position by a spring-actuated bolt in the shape of a ball engaging in a corresponding recess. This form of connection, which resembles one that is fairly common on swinging doors, is also applied to the attachment of the distributer cover and other parts.

The Guenet Magneto.

In the Guenet magneto the four magnets, arranged in two pairs, form a short tunnel for the armature, which is correspondingly short and rigid. Both the armature and the distributer shaft rotate in ball bearings. The contact breaker is of the bell crank lever type, one end of the lever being formed as a skid which slides over two oppositely disposed inclined planes. The planes are formed on fibre blocks mounted adjustably in the stationary (except for timing purposes) part of the contact breaker. The primary current is brought to the insulated platinum point of the contact breaker by the usual axial bolt. The head of the bolt also conducts the current to one side of the condenser, which is enclosed in the contact breaker cover and does not rotate. The high tension portion of the machine is on standard lines, and includes a simple visible safety spark gap.

The Hall.

The Hall or Hall-E.O.A. system is of the dual magneto and battery variety. A special point is made of the fact that the battery section of the apparatus may be run continuously and not merely for starting purposes. For the sake of clearness, however, we will deal first with the magneto part of the system alone, and then consider the battery and coil additions.

The magnets consist of two single units which are placed edge to edge to form the usual tunnel. They are held in position longitudinally by the

brass end plates which are fixed by screws to the ends of the brass base. All that is required in addition are two bolts to lock the magnets in place and these pass through holes formed at the abutting edges of the magnets, each of which is thus only pierced to the extent of two semi-circular notches instead of a number of complete holes.

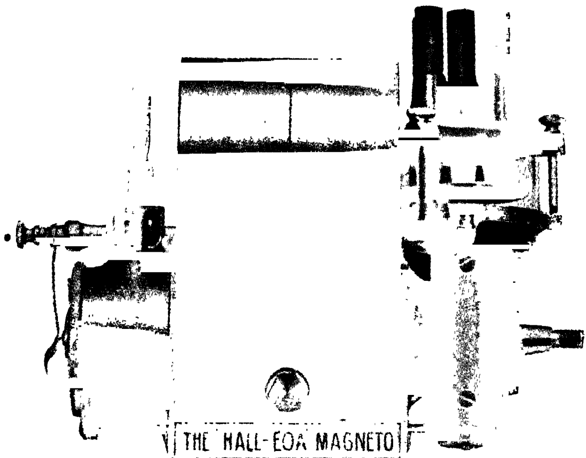

Fig. 81.—The Hall-E.O.A. Magneto.

This is one of the numerous little dodges which are characteristic of this ingenious machine. The soft iron pole pieces are of the usual channel form and are fixed to the magnets by the above-mentioned bolts, the heads of which bear on the outside of the magnets. The pole pieces are also secured to the base by vertical screws.

The bases are drilled with fixing screw holes so spaced that the different patterns may be interchanged with each other and with other well-known magnetos without altering the driving connections.

The armature is built up of a laminated centre and solid end pieces ; all three parts being held together by longitudinal rivets. The armature is capped by brass discs having outwardly extended bosses on which are mounted ball bearings with large balls. The driving spindle is fixed in one end plate and is supported by an additional ball bearing.

The windings comprise the usual short, coarse, primary and long fine secondary, and one end of each is earthed to the armature core. The hollow boss of the other end plate is bifurcated by two wide slots of different widths and arranged diametrically opposite to each other. The outer end of the primary winding is insulated and led through this bifurcated hollow boss to one end of a small rod which passes horizontally and eccentrically through the body (13) of the vulcanite slip ring which slides over this boss. The other end of the rod is connected to a metal disc (6) let into the outer end of the slip ring body (13). This brings us to the contact breaker, which is of unusual construction in some respects. The cam is ordinary enough, consisting as it does of a ring with two excrescences mounted on the end of the hollow boss beyond the slip ring. Both these rings have internal projections which engage in recesses formed by the bifurcating of the hollow

boss. This enables the rings to be "positioned," easily and accurately, and they are locked in place by the hollow plug nut (12).

In most modern magnetos the platinum points are disclosed on removing a cover, but in the Hall they are mounted on the cover itself. An insulated spring plunger contact (4) is mounted in the centre of the cover and its inner end bears against the disc (6) and picks up the primary current therefrom. The stationary, but adjustable, platinum-pointed screw (8) is carried by a bracket (5) in electrical connection with the plunger (4) but insulated from the cover (7). A short lever is pivoted in a bracket on the wall of the cover; it carries the moving platinum point at one end, and at the other a fibre pad which makes contact with the cam. The lever is operated by the cam against the action of a blade spring which tends to hold the platinum points in contact. With this construction it is obviously impossible to adjust the gap between the points while the parts are in position, but a little dummy cam is housed in the cover and may be slipped on to the central plunger and worked against the lever for adjusting purposes. A slide-covered aperture allows the points to be inspected while actually at work. Normally, the primary current is short circuited through the platinum points, the rocking lever, the cover (7), and the frame of the magneto; but when the points break contact, a high tension current is induced in the secondary winding and the condenser performs its dashpot duties in the usual way.

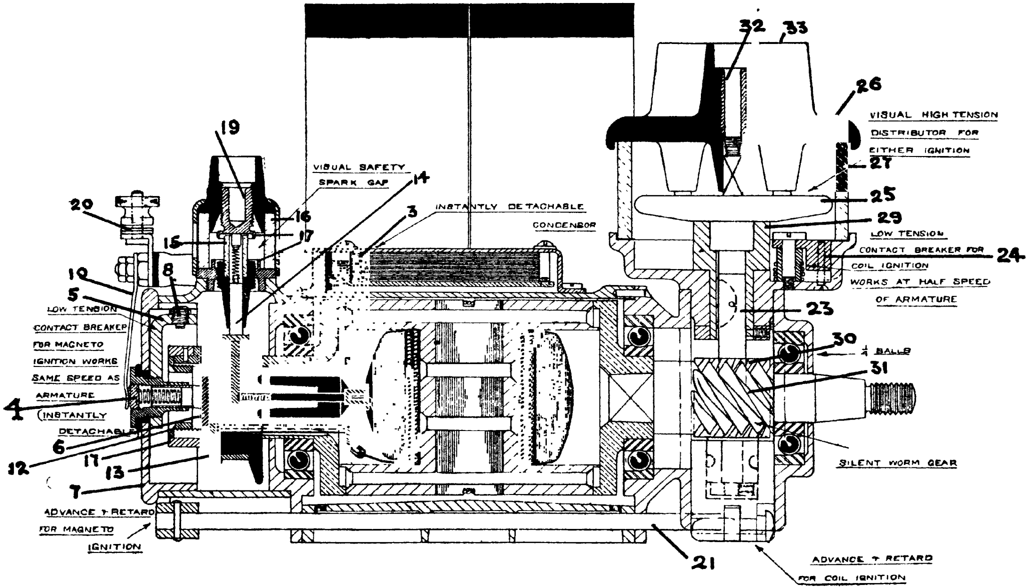

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Fig. 82.—Longitudinal Section of Hall Magneto.

The condenser (3) is built up of tin-foil and mica leaves and is located above the armature, to which it forms a readily detachable and replaceable cover. One side is earthed and the other side is coupled up to the live end of the primary winding by the spring blade (10) which bears on the head of the insulated plunger contact (4).

The live end of the high tension winding will be noticed on the axial line of the armature. The current is conveyed from it to the metal band of the slip ring by axial and radial metal rods embedded deeply in the insulating material (13).

The high tension current is collected from the slip ring by the spring-pressed and insulated carbon brush (14), and is conveyed by the spring to the metal socket (19) in the vulcanite socket. A plug fixed to the end of an insulated wire transmits the current, *viâ* a switch, to the distributer.

The bolt (20) to which the blade spring (10) is secured also serves as a terminal for a second wire which is also led to the switch and allows the primary current to be earthed continuously when required, thus putting the magneto out of action for firing the charges.

The safety spark gap is arranged at this part also. Two metal rings (17) with serrated edges are arranged at a suitable distance apart in contact with an earthed and an insulated metal part respectively, and concentrically with the carbon brush (14), but shielded therefrom by a glass tube (15), while an outer glass tube (16) prevents any stray petrol vapour getting access to the spark yet leaving the latter easily visible.

The distributer is arranged in a vertical position as illustrated. The gear wheels (30 and 31) are skew gears, cut on the worm principle, so that the diameters remain constant, but different gear ratios are obtained by altering the angles of the teeth.

The distributer shaft telescopes into the cam portion (29) and cannot rotate independently of the distributer table (25). Hence, if the shaft (23) with its skew gear (30) be moved up or down by the link rod (21), it will rotate through an angle relatively to the angle of the teeth, which are made to slide past one another.

The link rod (21) extends through the base and is coupled up at the other end to the magneto armature contact breaker (7), and when rotated actuates both the contact breaker (7) and the cam (29) for the coil ignition, but in consequence of the added angle on the gear wheel (30) an accumulating advance movement is imparted to the coil cam, thus giving 57 degrees advance on the coil while 30 degrees is being obtained on the magneto armature, which increment advance provides against coil lag and makes both ignitions of equal speed.

The control of the timing is effected by connections from the lever on the steering wheel to a lever on the rod (21).

The high tension current is conveyed from the collector socket (19) to the central socket (32) of the distributer by an insulated cable with suitable plug terminals. At the bottom of the socket (32) is a spring-pressed carbon brush which

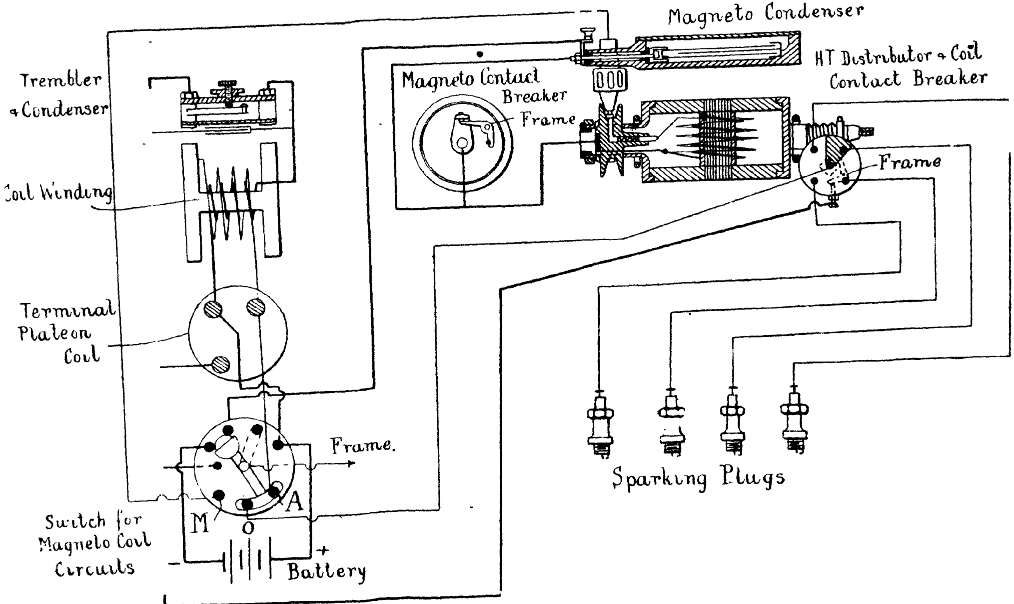

Fig. 83.—Diagram of the Hall Dual Ignition.

bears on a brass segment let into the vulcanite disc (25) which rotates with the distributer shaft. The distributer cover (26) carries on the under side a circular series of carbon brushes and on the upper side a number of vertical sockets (33) according to the number of cylinders. The metal segment rotates into contact with the carbon brushes in turn, and conveys the high tension current through them to the vertical sockets (33) and so to the sparking plugs. The distributer is enclosed by a glass wall (27) and the vulcanite cap is secured by three thumb screws. These may all be detached by the fingers, and render the distributer readily accessible without even removing the cables from their sockets. Or the whole apparatus may be removed *en bloc* from the distributer shaft after releasing a catch.

So much for the magneto as such. Now for the other part of the dual system. It comprises a 4-volt accumulator, in duplicate, a trembler coil, a switch mounted in the same case as the coil, and a contact breaker. The distributer on the magneto and the one set of sparking plugs with their leads serve for both systems. The battery contact breaker (24, 29) is operated by the distributer spindle (23). It is a duplicate of the contact breaker on the armature shaft, and is advanced and retarded by the rod (21), but to a greater extent as explained above, so as to compensate for the additional lag of the trembler on the coil. This contact breaker being located below the distributer can be watched at work through the glass (27).

The coil has a metal instead of a wooden case and varnish is employed instead of wax for insulating purposes so as to withstand the damp and heat of hot climates. The coil can be withdrawn from its casing, when the system will work indefinitely on the magneto side, and if the magneto side is disabled, the coil side will work independently of the magneto. The electrical connections between the live ends of the coil windings and the terminals are made by simple contact on placing the coil in its receptacle.

The switch lever is made stronger than usual, being intended for foot operation. It can be set to M. (magneto), O. (off), or A. (accumulator), as required. For re-starting the lever should be turned to the last of these positions; if the engine does not fire it will probably be because the platinum points are separated. The lever should then be pressed still further in the same direction against the action of a spring, when the insulated platinum point is coupled up to the negative pole of the battery, so as to complete the primary circuit and excite the trembler, with the usual result of a stream of sparks at the plug in the cylinder which is for the time being on duty. The spring returns the pedal to A. on the foot pressure being removed.

Six cables in all issue from the switch, and they are coupled up as follows:—One high tension cable to the collector socket (19), and the other to the distributer feeding socket (32); one low tension to the magneto contact breaker

terminal (20), another to the coil contact breaker terminal on the distributer, and the last back cable to earth. The terminal on the bottom of the switch is coupled up to the positive of the accumulator.

The Nilmelior Magneto.

The Nilmelior magneto is constructed by one of the pioneer firms in the manufacture of electric

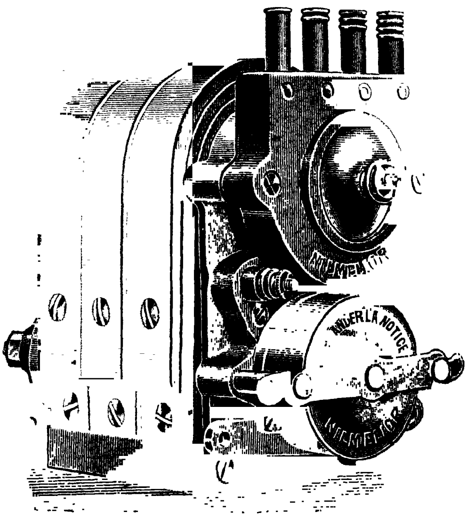

Fig. 84.—The Nilmelior Magneto.

ignition apparatus—Bassée and Michel, and is sometimes called by their name. For a time this magneto was of the single winding and separate coil type, but it is now quite self-contained and is a true high tension magneto.

The magnets are made from tungsten steel and vary in number in different patterns. They have separate pole faces which fit the armature with a very small air gap. The laminations of the core of the armature are insulated. The primary wire is first wound on to the core, and over this comes the fine high tension wire which makes some thousands of turns and extends to several miles in length. The inner end of the primary is earthed to the armature and the outer end is joined to the inner end of the secondary.

The armature runs on ball bearings. One of the spindles is made hollow for a central bolt and disc connection to the junction of the windings. The bolt holds the rotating contact breaker, but this is of quite unusual construction. The platinum pointed screw is mounted in an insulated bracket, but it lies parallel to the bolt instead of transversely to it. Behind the bracket is a flat ring spring fixed at one side to an arm rotating with the armature. The spring ring is concentric with the bolt and the armature, and at a point diametrically opposite the point of attachment to the arm is fixed the other platinum point, end on to the platinum pointed screw. Beyond, that is radially beyond, the fixed platinum point a steel block is fixed to the spring. This block rotates against the back of a fibre ring which forms an internal flange in the contact breaker cover. There are two projections on the back of the fibre ring, and each time the steel block encounters these the platinum

point on the spring breaks contact with the platinum pointed screw, with the usual result.

Advancing and retarding of the spark are obtained by turning the fibre ring, which is fitted with a brass arm for the purpose. The contact breaker is keyed to the armature at such an angle that on

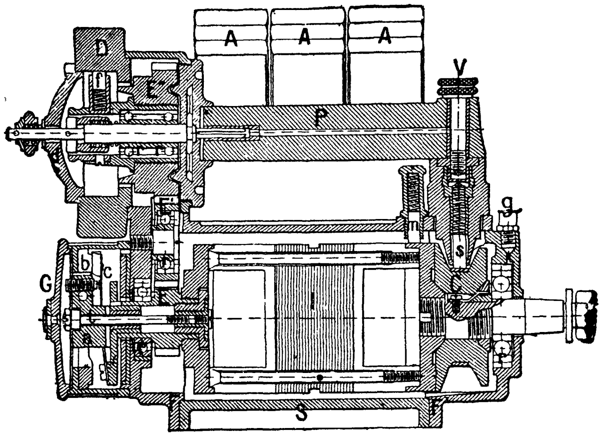

Fig. 85.—Longitudinal Section of the Nilmelior Magneto.

A, magnets; C, high tension collector ring; D, distributer; d, distributer cover; f, distributer carbon, E, E′, E″, distributer gear; F, end plates; G, contact breaker cover; I, armature; P, high tension connection; S, base plate; V, screw fixing connection, a, support for platinum screw; b, fibre cam; c, contact spring, platinum tipped; g, lubricator; m, earth carbon; r, ball bearings; s, high tension carbon; t, central bolt; v, platinum screw.

full retard the platinum points are just about to break contact and the armature is in one of its maximum positions.

A special device is provided for adjusting the platinum screw to the right width of gap. The contact breaker cover with the fibre ring are

removed, and a gauge consisting of a piece of thin metal mounted on a small pillar for the purpose, is swung over in front of the ring spring. The armature is rotated until the steel boss on the spring bears against the face of the gauge. The contact screw is then turned until the spring is pressed so far back that it only bears on the gauge just hard enough to prevent its swinging down. A grip screw is provided for locking the platinum screw, and a shaped plate prevents accidental turning of the central bolt.

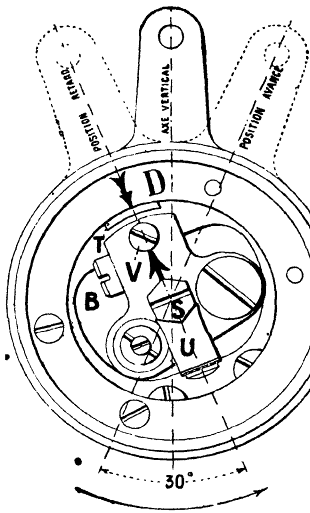

Fig. 86.—The Nilmelior Contact Breaker.

The return primary current is given an easy path through a spring-actuated carbon brush mounted in the armature cover plate and bearing on the disc at the driving end of the armature.

The condenser is now arranged at one end of the armature, instead of being wrapped round the core.

The distributer is placed above the contact breaker and is driven by a train of three wheels.

The large wheel is of fibre and is mounted on ball bearings. The wheel has a metal boss carrying a radial socket. The high tension current is collected from a slip ring and conducted through the tunnel to the distributer spindle and the radial socket which contains a carbon brush which wipes over the usual metal fillets in the distributer block. The fillets are coupled up to sockets which receive metal spigots on the ends of the sparking plug wires. The insulating caps on the spigots have 1, 2, 3 and 4 rings formed on them according to the numbers of the cylinders they serve.

The switch wire for short circuiting the primary and stopping the ignition is connected to a terminal on the end plate near the contact breaker and distributer.

Two safety spark gaps are provided by two screws directed towards the slip ring, one at each side of the machine.

The U.H. Magneto.

This magneto, which is also called the Master in the United States, is made up with three pairs of "horseshoe" magnets and an H armature runs in ball bearings between the cast-iron pole pieces. The base, end plates and armature cover are all cast as a single unit in aluminium alloy. The winding is on the continuous system, that is, the inner end of the secondary is attached to the outer end of the primary.

A special feature consists of the contact breaker, in which the platinum points (C) are

arranged parallel to the axis of the armature. The insulated platinum point is mounted on a compound spring built up of two double cross-bar springs attached to a single flat looped spring. The earthed platinum point is fixed to the steel base plate of the contact breaker, opposite the insulated point. A fibre block on the end of the single spring near the platinum point makes contact at every half-revolution with cam blocks on a ring (A) fixed in the contact breaker case, which may be moved through an angle for timing purposes, as usual. A spring notched nut is provided for adjusting purposes, and is marked so that it can be returned to its original position when desired. A gap allows of the points being readily inspected in position.

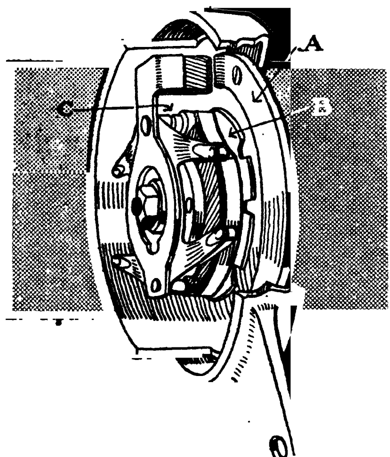

Fig. 87.—U.H. Contac Breaker.

The contact breaker is held in place by a conical nut on the end of the axial screw. The short circuiting terminal carries a spring-actuated

carbon brush, which bears on the head of the axial screw.

The high tension current is collected from a slip ring at the driving gear end of the magneto,

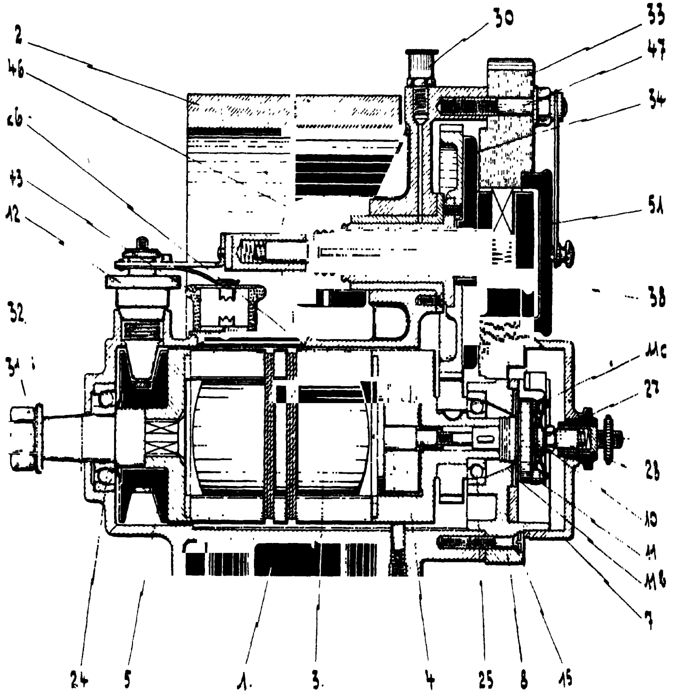

Fig. 88.—The U.H. Magneto.

1, base; 2, magnets; 3, armature; 4, condenser; 5, slip ring; 7, contact breaker cover; 8, contact breaker base plate; 10, axial bolt; 11 (11b), adjusting nut; 11a, platinum points; 12, high tension collector; 24, 25, ball bearings; 26, armature cover plate; 27 and 28, switch terminal; 30, lubricator; 33, distributer block; 34, insulating disc, 38, distributer arm; 43, spark gap; 46, insulating cap; 51, distributer cover.

and passes along a bridge to the distributer spindle and thence to a radial socket containing a spring actuated carbon pencil or brush. From this brush the current is picked off and distributed to insulated metal contacts in the distributer block, and so to sockets, leads, and sparking plugs in the usual way. The distributer spindle is fitted with oil flanges. The spark gap consists of a pair of points, one on the armature cover and the other on a metal cap introduced into the high tension circuit. The cap rests on a steatite ring and has windows in the top.

A two-spark pattern U.H. is made. It is constructed with a duplex armature, the two sets of windings being separated by a pair of condensers. The high-tension current from one secondary winding is led to one radial distributer arm as in an ordinary single spark magneto. The second slip ring is near the contact breaker end of the machine, and its carbon collector is coupled to the forward distributer feeder by a short length of outside cable with a spring clip connection. The distributer carbons are of large rectangular section. The contact breaker is fitted with two pairs of platinum points set at an angle of 90°, one pair acting for each primary circuit. Ordinary sparking plugs are employed.

In order to give a good spark at starting a catch and spring device is employed, which holds the armature stationary until the spring is wound up and then releases it, so that the spring snatches it round and makes a rapid break at the platinum points, although the starting handle be turned

quite slowly. The driving shaft is separate from the armature spindle and a plate is secured to each. A strong coil spring connects the two plates and is normally wound tight enough to transmit the drive without backlash. Stops on the respective plates prevent the spring unwinding, but allow of its being further wound up to a certain extent. When the armature is stationary a ball drops into a recess and locks it to the pole pieces.

Turning the driving spindle now winds up the spring until a recess in the plate on that spindle allows the ball to escape, when the armature being released flies round as described. At low speeds this series of operations is repeated, but in normal running the ball is held out of action by centrifugal force.

The Mira.

The Mira S.C. high-tension magneto has no less than 12 tungsten steel magnets arranged in four triplets, thus providing a very large active surface. The armature is of H form with laminated body. The body, end pieces, and bridge discs are all secured together by long bolts.

The low tension axial terminal and the high tension slip ring are at one end of the armature, and the 2 to 1 gear wheel is fixed to the driving end of the armature shaft. The contact breaker is mounted on the half-speed shaft behind the distributer. Thus it works at half the usual speed, and is actuated by a 4-phase instead of a 2-phase cam to get the required number of

breaks. The contact breaker is of the bell crank type, carrying a platinum point and a roller at the ends of the respective arms. A blade spring conducts the low tension current from the axial terminal to the stationary platinum point of the contact breaker, and to the one side of the condenser which is placed over the armature. A further terminal is adapted for short circuiting the primary circuit through a switch.

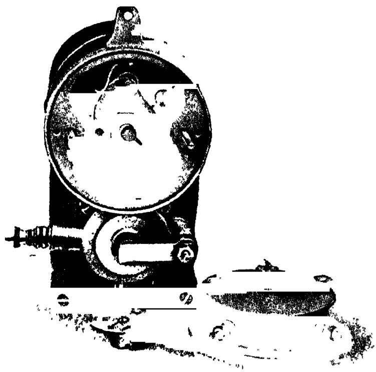

Fig. 89.—Mira Magneto with Distributer and Distributer Arm removed.

The high tension current is collected from the slip ring by a carbon pencil and conducted to an arm which rotates close to the metal fillets in the distributer body, leaving a small air space or spark gap. The distributer and contact breaker are readily detachable. The distributer shaft passes through the arch of the magnets and turns

in plain bearings, but the armature is mounted in ball bearings.

A special switch is provided for dual ignition and is adapted to cut both the high and the low tension currents. It is provided with a push button for starting on the battery and coil.

The N.F. Magneto.

Most magnetos are now made in a large variety of styles to suit different motors, and this is true of the N.F. The general construction is much the same in all, and the model about to be described is the one supplied for the 4-cylinder cars, say, up to 12–14 h.p. There are two single magnets mounted on a base of aluminium alloy, and having end plates of the same material. The armature, which has a laminated core, rotates in ball bearings. The wires of the windings are insulated with an elastic enamel, and there is a thin layer of gutta percha insulation between the primary and secondary windings, which are connected together. The live end of the primary winding is bolted to an insulated metal disc at one end of the armature. The spindle at this end is hollow, and has a tubular lining of insulating material. A central bolt passes down the tube and screws into a boss on the disc. The bolt holds the rotary contact breaker in position, and it conducts the current to an insulated bracket, in which the adjustable platinum point is mounted. The other point is on one end of a bell crank lever. A double-

leaved brass bow spring holds the points normally in contact, and forces a fibre block in the other end of the lever outward. At each half revolution the block encounters a steel cam in the interior of the contact breaker cover, and is pushed back against the action of the spring and so causes the points to break contact.

The condenser is carried in the outer end of the contact breaker cover. One side of it is coupled to the primary winding by a carbon brush carried by a blade spring and bearing against the head of the central bolt. The other side of the condenser is earthed through the metal frame of the cover. The contact breaker cover can be rocked for timing purposes.

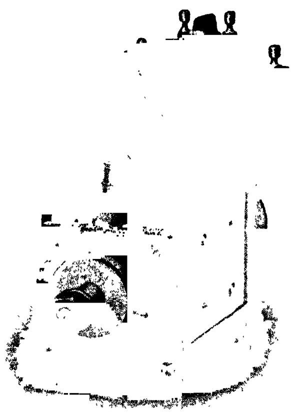

Fig. 90.—The N.F. Magneto.

The live end of the high tension winding is connected to a metal slip ring in a vulcanite trough. The current is picked off by a radial carbon brush, and is conducted through the magnets tunnel to the distributer. A fibre and aluminium pinion on the armature spindle behind the contact breaker drives a similarly constructed

spur wheel twice its size on the distributer, the fibre of the one gearing with the aluminium of the other. The carbon brush which receives the current from the slip ring is contained in a holder with a terminal top. This terminal takes the plug wire in the single-cylinder magnetos.

In the four-cylinder pattern a detachable connection leads the current to a metal stud behind the distributer, and thence the current passes by another carbon brush to a radial brass strip in an ebonite disc fixed to the half-speed gear wheel. The brass strip terminates at a horizontal socket of the same material set eccentrically in the ebonite disc. In the socket is a horizontal carbon brush which bears in turn on metal face contacts in the detachable distributer block, which is made of vulcanite. The contact blocks are coupled up to the usual terminals for the high tension wires leading to the sparking plugs. A safety spark gap of lantern form is arranged behind the distributer. The contact breaker block is attached by a kind of bayonet joint locked by a spring plunger. There is a swinging spring blade on the front of the block which serves to hold the contact breaker in place. A terminal is provided just above the blade for the attachment of a switch wire for shorting the primary circuit and stopping the ignition. The primary current passes to the switch terminal through the centre of the condenser out to an insulated disc in the end of the contact breaker cover, and thence by the swinging blade to the bracket which carries the blade screw and the terminal itself.

The Thomson-Bennett Magneto

is of itself of ordinary construction, with ball bearing armature carrying the condenser, and the spark gap located in the distributer cover. A special feature introduced into some patterns consists of a differential gear between the driving member and the armature. The intermediate pinion of the gear is provided with a lever, and so long as this is held stationary the magneto operates as usual, the only peculiarity being that the armature runs in the direction opposite from the driving member. But if the lever be moved, the relative angular positions of the driving member and the armature are altered more or less, and the effect is utilised either for starting or for running purposes.

In the former case the lever is operated by a spring which is controlled from the dashboard. By these means, when the car is ready to start, the lever can be moved smartly through about a right angle, the gear doubles the movement at the armature, which must thus pass through one of the maxima positions at which the points separate, and a spark is caused. The distributer ensures that the spark occurs in the cylinder containing the compressed charge, and the engine starts.

In the other application of the gear the contact breaker is fixed to the armature and the break therefore always occurs at a certain position relatively to the armature. But by working the gear lever the armature itself, as well as the contact breaker, is advanced and retarded and

can be adjusted through an indefinitely wide angle according to the speed at which the engine is running or is desired to run.

The K.E.W. Magneto

is designed very much on standard lines. The body is constructed as a single casting to ensure rigidity, maintain alignment, and exclude dust. The armature has a laminated core. The high and low tension windings are continuous, and

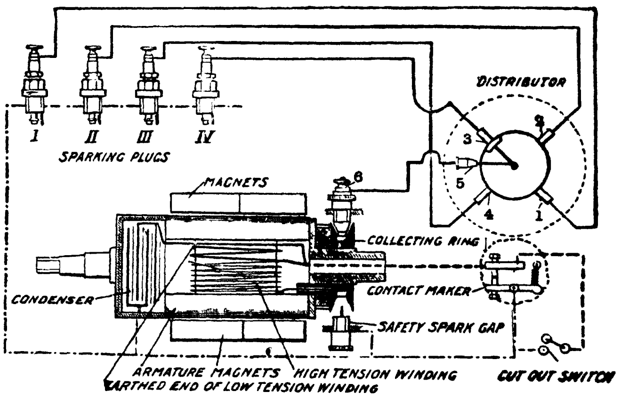

Fig. 91.—Diagram of K.E.W. Ignition.

a branch runs off from near the junction to one side of the condenser, which is housed in one end of the armature. The bell crank lever of the contact breaker is operated by a fibre cam encased in a metal ring, which is supplied either fixed or movable for timing purposes. The safety spark gap is provided between an earthed pin

and the slip ring of the high tension collector. Special claims are made for ease of starting and moderateness of price.

The C.A.V. Magnetos.

A complete range of these machines is made suitable for single, twin, four and six cylinder

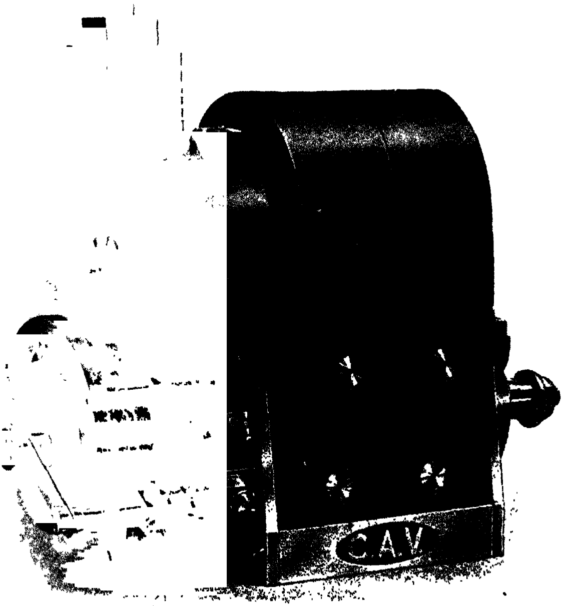

Fig. 92.—The C.A.V. Magneto.

engines, the design of which follows generally the usual magneto practice, but every type is fitted with

substantial ball bearings. A novelty is found in the latest pattern four and six cylinder dual ignition machines, in the shape of an arrangement for

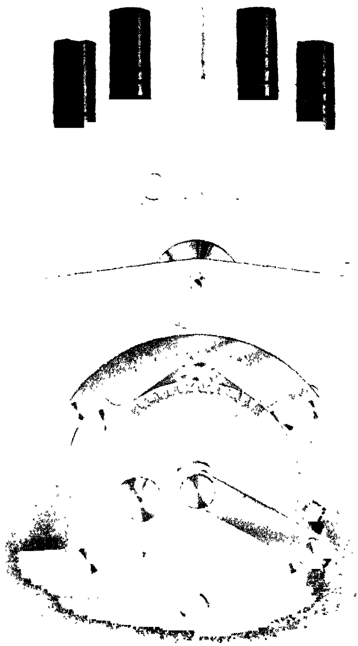

Fig. 93.—The C.A.V. Magneto, End View.

synchronising the two ignitions. Owing to the "lag" which occurs in the trembler of the coil, a larger range of advance and retard is

necessary for the coil and accumulator than for the magneto.

To obtain this a small pinion wheel is fitted on a projection at the upper part of the contact breaker cover, and engages at the top in a circular ratchet arm, and at the bottom in a ratchet segment fitted into the cap of the contact breaker, which latter also forms the low-tension contact maker for the battery ignition. By the accompanying illustration it will be seen that when the advance and retard lever is moved through a certain range the low-tension plate is moved through approximately double the angle, thus making up for the "lag" above referred to.

The distributer connections are simplified by the addition of an extra plug terminal, through which the high-tension current passes from the coil or the magneto (according to whichever system of ignition is being used), to a double brush, by which latter it is distributed to the other four plug terminals. The half-time wheel on which this brush holder is mounted, runs on a double ball bearing.

Provision is made for rotating the distributer through a certain arc without using long distributer segments, which might cause trouble on account of short circuiting. This is rendered necessary on account of the wide range of advance and retard required by the coil and accumulator portion of the ignition.

The high-tension coil is of the usual trembler distributer type, with the combined high and low tension change-over switch disposed in the base.

The Ruthardt Magneto.

In the Ruthardt magneto the magnets, instead of being of the usual arched form, are nearly cylindrical in shape. They are packed closely together and ground smooth on the exterior. The end plates and base are of aluminium and complete a light, compact and shapely structure,

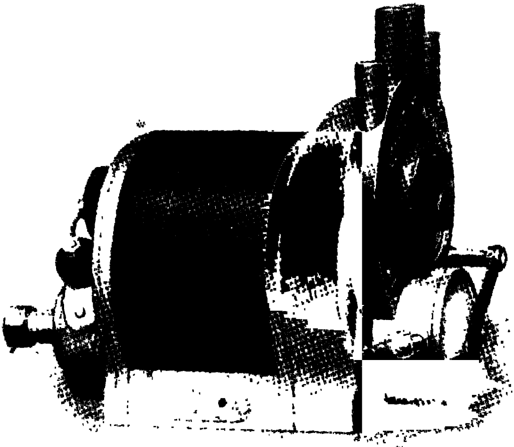

Fig. 94.—The Ruthardt Magneto.

while the contact breaker and collector are neatly encased.

A peculiar and good feature of construction consists in making the pole pieces integral with the magnets themselves. How this is attained will be easily understood by imagining each magnet to start its existence as a disc. Each

disc has a hole machined through it like a large figure 8. The two loops of the 8 communicate, and the lower one breaks through the lower edge of the disc. The magnets are therefore of double claw-like form, the sides of the claws or the lower loop of the 8 forming the pole faces without the use of any additional pieces, which are apt to impede the free flow of the magnetic lines of force.

The shuttle armature rotates in caged ball bearings, and the high and low tension windings are carefully insulated from one another. The condenser is mounted on one end of the armature, and the spindle at the same end carries the very simple contact breaker. In most magneto contact breakers the moving platinum point is fixed to a lever which is controlled by a spring, but in the Ruthardt the lever is dispensed with, and the platinum is riveted to the spring itself. The other platinum point is mounted in an oblong bracket or block arranged at an angle to the radius of the contact breaker. A stud projects from the face of the contact breaker plate and a fibre washer is hung loosely on it. The washer lies in the wide part of the angle formed by the inclined side of the bracket and the end of the blade spring.

On the inside of the contact breaker cover are two diametrically opposite projections, and on rotation of the contact breaker the washer encounters these and is forced further into the angle, so as to push out the spring and separate the platinum points. The cover and projections

can be rocked through an angle to advance and retard the timing. A terminal on the cover is connected by a spring tongue with the primary circuit, and may be connected to earth by a switch for cutting out the ignition, while a safety

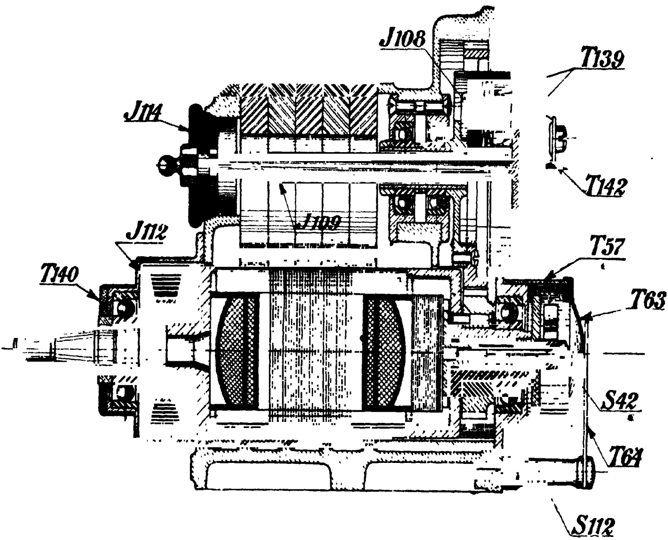

Fig. 95.—Longitudinal Section of the Ruthardt Magneto.

spark gap guards the insulation in case of a high tension lead becoming detached.

In the Ruthardt magnetos for one and two cylinder engines the high tension current is taken off direct from a slip ring at the driving end of

the armature, by a similar number of carbon brushes and terminals. For multi-cylinder engines, the same arrangement, with a single brush, is employed in conjunction with a ball bearing half-speed shaft and distributer. The shaft is located in the upper tunnel through the magnets, and is driven from the armature through a pair of wheels. The shaft is insulated, and current is conveyed to it from the collector by a short and easily detachable wire. The other end of the shaft carries a metal disc, and the current is collected from this by one horizontal carbon brush and is distributed by a similar brush to insulated blocks and detachable leads in much the ordinary way.

The larger magnetos are supplied with a dummy base to be secured to the *chassis*, the magneto being coupled to this by an instantaneously releasable band with spring clip fastening.

Bosch Two-Spark Ignition.

In addition to the Bosch Dual Ignition there is a system for producing two sparks simultaneously from one magneto. In this arrangement certain parts are duplicated. Thus there are two metal insets in the high tension slip ring; two collector carbons set diametrically opposite one another, as in a two-cylinder magneto; two safety spark gaps; two high tension conductors; and two radial distributer brushes with two sets of metal insets in the internal track. Instead of con-

necting up one end of the secondary wire to the primary, the secondary is separated from the primary and the two ends of the former are connected to the respective metal segments in the slip ring. One of the spark gaps is connected with the distributer by the usual insulated rod passing through the arch of the magnets; the other spark gap is connected with the front distributer arm by a short length of cable attached to the spark gap, and to a terminal in the centre of the claw bracket which holds the distributer cover. This terminal is in electrical connection with a carbon brush which bears against a metal centre in the block carrying the forward distributer arm. The sparking plugs and their leads are also duplicated, so that in ordinary working both plugs in each cylinder spark simultaneously, the current passing from the central electrode of one to the metal of the cylinder head, thence to the body of the other plug, across to its central electrode and back to the magneto by the other wire. By means of a special switch either end of the high tension winding can be earthed, so that one can run on one set of plugs, or the other, or on both, or the primary can be shorted through earth when the firing is stopped altogether.

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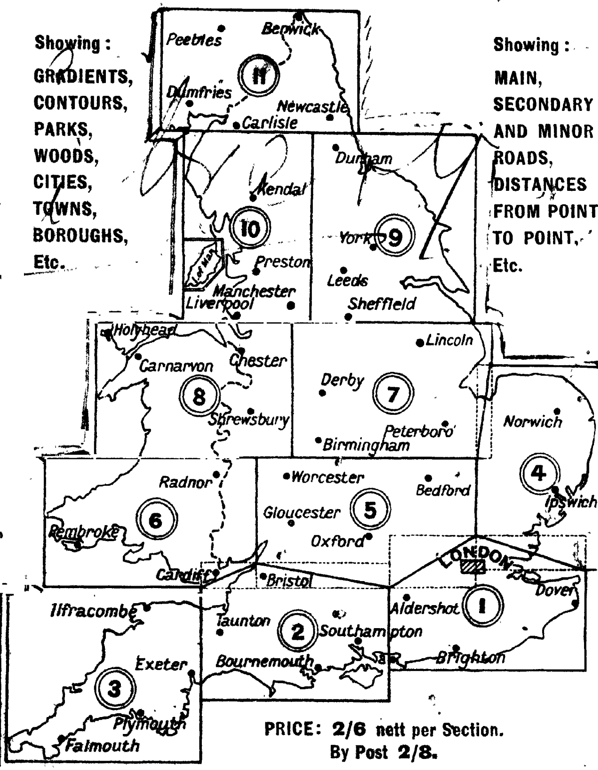

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